**MSC**

# The Origin and Development of the Alcester waterworks Company, 1875-1947

Johnson, Cyril Joseph

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### Abbreviations

The following abbreviations are used to represent certain archives throughout the thesis:

| | |
|---|---|
| PRO | The Public Record Office |
| WRO | Warwickshire County Record Office |
| ROW | Worcestershire County Record Office |

The following references have been used repeatedly in abbreviated form, and their meanings are given below:

| | |
|---|---|
| WRO, CR114a/736,1 & 2 | The Ragley Papers |
| WRO, CR 51/92 | Minutes of the Alcester Rural Sanitary Authority |
| RSA | Rural Sanitary Authortiy |
| RDC | Rural District Council |
| AC | *The Alcester Chronicle* |

# Contents

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## Chapter 1 : Introduction

In nineteenth century Britain there took place a great expansion in the provision of public water supply. At the beginning of the period very few of the inhabitants of British towns lived in houses connected to public water mains and those that did belonged largely to the wealthier classes. By the turn of the century all great towns and many lesser ones were supplied with piped water, and the homes of even the poorest were connected. In rural areas however the situation was far worse. Many villagers depended on ditches, pools and wells for their water, and things did not improve in country areas until the middle of the present century. Nevertheless, the achievement made in the nineteenth century was considerable and was a result of an increased demand for water on the one hand, and technological advances which enabled supply to meet the increase.

In order to set these changes in their historical perspective it is necessary to consider the situation before 1800. A number of the larger provincial towns had been supplied with piped water by the end of the seventeenth century, as a result of the activities of the Derby engineer, George Sorrocold. These were predated however, by a scheme in London which was based on pumping water from the Thames and piping it to the eastern parts of the city. Engineered by the Dutchman, Peter Morice, it used a waterwheel in an arch of London Bridge as a power source for the pump, and was in operation in 1582.

Chester was provided with water from the Dee as early as 1600[1]. Such supplies would nowadays be regarded as highly suspect, but another of the very early schemes, that of the New River Company, supplied London with excellent water from Hertfordshire from 1609 onwards, the Company being taken over by the Metropolitan Water Board in 1904. At first the supply was entirely by gravity but pumping was later used when the mains were extended to higher parts of the capital.

The greater part of the country was unaffected by these very local undertakings of course and it was not until the 1690's when Sorrocold began with the Derby installation, that provincial towns made any widespread attempts to improve their public water provision. The Derby scheme dates from 1692. Water was pumped from the River Derwent to a storage cistern whence it gravitated to the houses and public conduits. So successful was this municipal undertaking that it continued to provide the main supply of water to Derby until the 1850's. Like the London Bridge scheme, the first of Sorrocold's projects used a waterwheel to drive the pumps and similar arrangements were employed in his later works in Norwich, Leeds, Bristol and a number of lesser towns. Eventually Sorrocold was involved in Marchant's Waterworks in London (1696) and was responsible for extensions and improvements to London Bridge Waterworks in 1701.[2]

All these schemes supplied only the houses of those wealthy enough to pay for the service. The poorer classes had to fetch their water from the public fountains and conduits. Sometimes the supply was from a standpipe in the street which only delivered water for a short time each day; often there was no supply on Sundays. Such arrangements were common in London in 1840 and as late as 1850 in the capital, some 80,000 houses and 640,000 persons had no household supply whatso ever.[3]

The 18th century saw the beginnings of the use of steam power for pumping, first in the form of Newcomer's simple but effective atmospheric engine, later in the more efficient engine which resulted from Watt's improvements. A Newcomen engine was at work pumping water from the Thames as early as 1726 at the York Buildings' waterworks, but its use ceased in 1731 when the company got into financial difficulties.[4] The low thermal efficiency of Newcomen's engine, of little importance in the colliery districts where fuel was cheap, severely limited its usefulness in other areas and for other purposes. The general use of steam power for water pumping as opposed to mine drainage did not come about until later in the century; steam engines were installed by Smeaton for York Waterworks in 1781 and by Watt at Hull in 1795. Both were of the more efficient type resulting from Watt's invention of the separate condenser.[5]

The eighteenth century also witnessed the start of the process of urbanisation which was to increase rapidly in the nineteenth. Not only did the population of Britain increase, but its distribution altered, with most of the growth occurring in the new industrial centres. While the population of the country as a whole doubled between 1801 and 1851, that of Glasgow grew at twice the average national rate.[6] Likewise, Manchester's population quadrupled between 1801 and 1841 and similar increases occurred in other industrial towns. The water supplies for such places did not expand to match the population growth however, and as the poorer classes lived in overcrowded conditions, disease took a heavy toll. In the worst areas of such towns the average age of death in 1840 was thirteen years, 50% to 60% of all deaths being those of infants under five. By comparison, the average age of death for the whole country by 1940 had reached 58 years, mostly as a result of the fall in infant mortality.[7]

Much of the mortality in the early 1800's was due to infectious or contagious diseases. Typhoid fever, smallpox, diphtheria, scarlet fever, and above all pulmonary tuberculosis (known to the Victorians as ‘the captain of the armies of death’) were the regular killers, with cholera swelling the mortality statistics from time to time. All of these were diseases which flourished in poor and insanitary living conditions, and consequently the poor suffered more than the wealthy. Thus although the crude death rate, averaged over the whole country, was twenty-three per thousand in 1840, it reached thirty-nine per thousand in overcrowded towns.[8]

The association between bad living conditions and disease was appreciated in the 1830's, but the mechanism which makes one a cause of the other was unknown and remained so until much later in the nineteenth century. Even if the information had been available little could have been done, for until 1834 the country was devoid of any form of public health system whatsoever. Machiavelli remarked long ago upon the tendency of those in power rarely to do good, unless forced to it by necessity, and in nineteenth century Britain necessity appeared in the form of a series of devastating cholera epidemics; each was followed by some attempt at sanitary improvement. The passing of the Poor Law Amendment Act in 1834 marks the beginning of the public health legislation in this country, for it in turn led to the Poor Law Commission and this led to a full-scale enquiry into the living conditions of the urban poor. Published in 1844, the Report of the Commission for Enquiry into Large Towns produced abundant evidence of the association of ill-health with insanitary living conditions, but was unable to prove that one was the cause of the oth-

er. Opponents of sanitary reform were able to point to areas where the sanitation was bad but disease was absent; the part played by contaminated water in the infection process, which would have resolved the paradox, was unknown. Two schools of thought came into being, the sanitarians who held that dirt was of itself a cause of disease, and the contagionists who believed in the existence of some material 'poison' which, transmitted from one person to another, produced the infection. Victory went ultimately to the contagion school, but the efforts of the sanitarians improved public health, although the theory upon which their work was based is now known to be false.

The Poor Law legislation also produced the beginnings of public health medical practice; the new Poor Law Unions were to appoint District Medical Officers and Workhouse Medical Officers. These were used for public health investigations by Chadwick, the Secretary of the Commission, who required public health reports of them; living and working among the poor they were fully aware of the conditions under which the working classes lived.

Apart from the Poor Law Legislation, which bore only indirectly upon public health, little was achieved until the late 1840's, when the approach of the second cholera epidemic concentrated the attention of the then government on public health matters, and precipitated the first Public Health Act in 1848. This set up the first national body with responsibility for public health, the General Board of Health with Chadwick as one of its three members. The Act also allowed for but did not compel, save under exceptional circumstances, the formation of Local Boards of Health; some of the large industrial towns, where the circumstances were exceptionally bad, did acquire local boards as a result. A number of large waterworks schemes did date from this time; Manchester for example started to build the series of reservoirs in the Longdendale Valley which were to provide the town with nineteen million gallons of water daily.[9] The new legislation was too late to have much effect on the 1848-49 cholera epidemic, and by the time of the third in 1853-54, the General Board of Health had been dismissed, and public health was the responsibility of the Privy Council. It continued to be so until 1871.

The third outbreak of cholera was the occasion of one of the classic enquiries in epidemiology – Snow's investigation of the Broad Street pump as a source of infection. He was able to show that all the infection in a certain area of London could be attributed to water taken from a particular pump in Broad Street; when the handle of the pump was removed, new infections ceased. This was the first demonstration of the part played by water in cholera transmission, and that the disease was acquired by eating or drinking matter infected by excreta from a cholera patient. Although this was a major victory for the contagionists, the idea met with considerable resistance. Miasmatic theories of disease contended that infection resulted from the inhalation of an inorganic substance which was derived from decomposing matter and such notions were not entirely displaced until the end of the century.[10]

The final epidemic of cholera in 1866 produced the Sanitary Act of the same year, and ultimately the Royal Commission of 1869-71 which in turn led to the Public Health Act of 1872. This ordered the setting up of local sanitary authorities and defined their duties regarding the supply of wholesome water and proper disposal of sewage. The Local Government Board (established

in 1871) was to be the central authority with responsibility for public health. Finally in 1875 came the Public Health Act, introduced by Disraeli's Government, which consolidated and drew together the previous legislation on sanitary matters. This remained the cornerstone of public health in Britain until 1936; later Acts dealt with special topics needing attention. The Act of 1878 for example related to the special circumstances of rural areas where water supply was difficult and expensive.

The impact of the whole course of public health legislation on municipal water provision may be judged from the fact that whereas there were only eleven such undertakings in the 1830's, by 1878 the number had risen to 78.[11] In fact as early as 1847 the government had begun to regulate the activities of water undertakings with the Waterworks Clauses Act. This laid down the conditions under which companies traded, and their rights with regard to operations concerned with the breaking open of highways and the like. Another Act with the same title came in 1863, and the Gas and Waterworks Facilities Acts followed in 1870 and 1878. These latter two allowed companies to operate under Provisional Orders issued by the Board of Trade rather than incur the expense of obtaining private acts of Parliament. As a result of the last two pieces of legislation there was a further increase in the number of municipal undertakings in the last quarter of the nineteenth century and it has been estimated that by 1913 four-fifths of the consumers of water in Britain were supplied by local authorities.[12]

The influence described above resulted in an increase in the number of water suppliers, both commercial and municipal. Social pressures also tended to increase the demand for water. When water had to be carried to the house by hand it was generally regarded by the working classes as too precious to waste on personal hygiene. Chimney sweeps were believed to have washed only three times per year in the 1850's; many members of the poorer sections of the populace did not wash at all. Public bathhouses were established in London in the late 1840's but it has been calculated that in 1850 the number of public baths taken in the metropolis works out at one per person per five years.[13] With the expansion of piped water supply, general cleanliness improved and the consumption of water rose accordingly. In London again the average consumption worked out at seven gallons per head per day in 1844; by 1893 it had risen to thirty-one gallons.[14]

Expansion on this scale repeated over the whole country was only made possible by improvements in the technology of the location, extraction, treatment and distribution of water. The location of potential aquifers was wade more reliable as the geology of the country became better known and accurate maps were produced by the Geological Survey. Hydrology was aided by the gathering of rainfall statistics for the whole country by the British Rainfall Association from 1860 onwards. These became available for water engineers in the annual publication *British Rainfall* produced by the Meteorological Office, and systematized the work of predicting the water yields of surface catchment areas.

The work of extracting water was made easier by the development in the nineteenth century of the ‘Cornish’ engine. Thermally efficient because of its use of high pressure steam and capable of developing high power outputs for its cylinder size compared with Watt's low pressure engines, the Cornish engine was originally developed for mine drainage; waterworks used it either

for extracting water from deep boreholes or for pumping water to high level storage cisterns or reservoirs. Later in the century the gas or oil engine was applied to water pumping and provided a power source which offered valuable economies for small power outputs as compared with the steam engine.

Until the early 1800's water was distributed through mains made of bored elm trunks connected by simple cone and socket joints turned at the ends. The joints were sealed with pitch. Elm wood was chosen for this purpose because of its resistance to constant wetting; it was used for canal lock gates for the same reason. Because the wooden mains were very liable to leakage, water could only be supplied through them at low pressures. Consequently advances in pumping technology were of little use until some more suitable kind of water main became available. Between 1810 and 1820 cast iron pipes joined by bolts through flanges at their ends came into use, but as there were no effective expansion joints, the mains frequently cracked, and allowed nearly as much leakage as the wooden mains they replaced.[15] Suitable expansion joints were devised in due course, and it then became possible to supply water through the mains at a pressure high enough to raise it to the top storeys of buildings, where it could be stored in cisterns, making it possible for each building to have its own self-contained water system. Fixed baths and water closets thus became a more feasible proposition, at least for the better-off. Another innovation which aided efficient water distribution was the invention of the first effective sluice valve by James Nasmyth in the first half of the nineteenth century.

The increasing demand for water forced several large towns to undertake major civil engineering projects in the closing years of the century to bring water long distances from upland regions. Liverpool brought water from Lake Vyrnwy in Wales in the first of such schemes, Manchester impounded the waters of Thirlmere in the Lake District, and Birmingham went to the mountain country of mid-Wales. Each of these projects involved the construction of a major aqueduct (a very large pipe, in effect) and one or more large masonry dams. Such works only became practicable after the technique of building these dams was developed by civil engineers, mostly in France where Delocre and De Sazilly were important innovators in dam design.

Until microbiology was able to provide a scientific criterion of water purity, water treatment was mostly directed towards improving the clarity of the water. Attempts to filter the water through beds of sand began before 1800 in an attempt to supply the Lancashire textile trade with clean water and such filters were used to treat some of London's drinking water by 1827.[16] In 1852 it was made illegal for the London supply companies to distribute unfiltered water. It was later discovered that slow filtration through a sand bed would remove, as well as the visible sediment, most of the pathogenic bacteria present under normal circumstances and filtration remains an important part of water treatment.

The most harmful contaminant of a potential water supply is human sewage; this is normally indicated by the presence of certain micro-organisms abundant in the human gut, but not themselves pathogenic. Before microbiology had developed to the point where it could provide such a standard, a test based on the chloride ion concentration was used. This depended on the fact

that human urine has a high chloride ion content; water with an abnormally high chloride content was thus highly suspect. By the 1870's the work of Pasteur, Koch and others had set microbiology on a sound basis, and from 1885 the London water supply was subjected to systematic analysis.[17] Water obtained from deep wells and boreholes did not usually need to be filtered because it was 'fossil'water which had been subjected to filtration as it passed through the strata to accumulate in the aquifer.

The destruction of pathogenic organisms by systematic chlorination of water was first used in Italy in 1896 as an emergency measure during an outbreak of typhoid fever, and in similar circumstances in England in 1897, but the procedure did not became standard practice until well into the present century.[18]

The result of all these changes, together with improvements in sewage disposal was a decline in the incidence of waterborne disease. Typhoid fever for example was taking about 20,000 lives a year until the late 1860's and 12,000 in the seventies, but thereafter the figure dropped sharply.[19] The general death rate declined likewise. Whereas it had been about the same in 1875 as it had been in 1850, about 22 per thousand, it had fallen to 16 per thousand by the beginning of the present century.[20] The engineer, public health officer and microbiologist had begun to win a victory over disease and dirt. The twentieth century has seen no major change in water technology; electric motors provided a new and very convenient prime mover as soon as electricity supply was sufficiently extended, and either they or large high speed oil engines (commonly but incorrectly called diesel engines) are the usual source of pumping power at present. The development of more rapid filter systems has continued, although the old gravity sand filter is still used. Disinfection, by the injection of chlorine or ozone is now almost universal. Apart from these minor changes however, the provision of water supply is much as it was at the turn of the century.

Government regulation of the water supply industry has been greatly extended since 1900 however. In 1910 a Water Supplies Bill was introduced into Parliament with the purpose of restricting the activities of water undertakings, particularly with regard to abstraction rights. This bill provoked a discussion upon the general topic of the use and conservation of the nation's water resources, and the then government intended to incorporate the recommendations of the Joint Select Committee which had reported on the bill to this effect. Parliament was dissolved in 1910 before any action on the bill could be taken however, and the only practical outcome was the survey of water undertakings made at Parliament's request in November 1910 This required a return from every water undertaking giving details of the supply and sources, and the powers under which the undertakers operated. Every district in England and Wales was asked to give details of the supplies in its area.

The statistics obtained were published in 1915 in *The Return as to Water Undertakings in England and Wales*, and provide a comprehensive and invaluable account of the nation's water supply.[21] It was revealed that of 1130 boroughs and urban districts, 1101 had piped supplies , but 67 districts had over 5% of houses not connected. Of 12,869 rural parishes 8,085 had no piped water supply at all. Overall more than three quarters of the population of England and Wales had ac-

cess to piped water.[22]

From 1934 onwards there was pressure from the Ministry of Health (which had assumed the public health role of the Local Government Board in 1919) for a national water policy, and the Public Health Act of 1936 provided the Minister of Health with powers to authorise the amalgamation of water undertakings, whether companies or local authorities. A more general alteration of the law under which water suppliers operated was proposed and framed in a Water Undertakings Bill introduced in 1939, but interrupted by the outbreak of war. Re-introduced in 1943, the bill attracted considerable opposition from the British Waterworks Association and so many amendments were tabled that the bill was lost. In 1944 however, a White Paper was published with the title *A National Water Policy*. Amongst other things this proposed that the Minister of Health, supported by a statutory advisory body, should take responsibility for the nation's water supplies. Existing water undertakings were to continue much as before but strictly supervised.

These proposals, together with others, were embodied in the Water Act of 1945, which supplanted the Waterworks Clauses Act of 1847 as the basis under which water undertakings operated. Particular importance in the new act was laid on the conservation of resources and the regulation of abstraction from underground sources, hitherto uncontrolled.

The problems of rural areas received little attention until 1929, when the Local Government Act of that year empowered a Rural District Council to contribute towards the costs of providing a water supply to each of its constituent parishes; hitherto these had been required to bear the whole costs of such provision. As a result of the drought of 1934 the government passed the Water Supplies Act, setting aside £1,000,000 for the aid of rural supply schemes. This resulted in some 3,000 schemes being carried out by 1939, and the Rural Water Supplies and Sewerage Act of 1944 provided a further £15,000,000 for the purpose. The extension of water mains in rural areas for agricultural purposes and to provide for military camps and airfields aided the programme of improvement, although wartime shortages tended to delay matters. As a result of these and later allocations most villages in England and Wales now enjoy a supply of piped water.

This is the historical framework in which the origin and growth of the Alcester Waterworks Company, which supplied a small town in the midlands of England from 1879 until 1947, must be set. Attention must be given however, to the aspects of the Alcester Waterworks Company which make it worthy of study, and to do this it is necessary to consider the whole field of public water provision in the twentieth century.

The best overall picture of the water industry at this time is provided by *The Return as to Water Undertakings*. It shows that public water supplies were provided by four different kinds of undertaking, namely Local Authorities, Joint Water Authorities, water companies, and private proprietors. The companies may be subdivided further into those operating under powers provided by an Act of Parliament, those operating under Provisional Water Orders issued by the Board of Trade, and those without statutory powers of any kind. If we assume that the scale of a water undertaking is measured by the quantity of water which it supplied each day, then the average of this quantity for each category of supplier will enable a comparison to be made between these

types of undertaking. The results, taken from *The Return as to Water Undertakings*, are set out in Table 1.1 below.

**Table 1.1: A Comparison of Water Undertakings, 1915** (Based on *The Return as to Water Undertakings*)

| Type of Undertaking | Number of Companies | Average Quantity of Water Supplied Daily (thousands of gallons) |
|---|---|---|
| Local Authorities | 786 | 1772 |
| Companies : | | |
| (a) With Acts | 152 | 1192 |
| (b) With Water Orders | 48 | 133 |
| (c) Without powers | 84 | 35 |
| Private Proprietors | 1055 | 27 |
| | Total = 2160 | |

The crude average of course, can give a misleading picture in such circumstances. To take but one example, the Metropolitan Water Board at this time supplied 244 million gallons daily. Not only was it by far the largest Joint Water Authority and the largest supplier of any kind in the country, it supplied a volume roughly equal to two thirds of all the water supplied daily by the other Joint Water Boards put together.

The same picture is to be found for each of the other categories of supplier; relatively few very large suppliers tended to dominate the industry. Whilst most of the consumers received their water from the large concerns in the built-up areas, most of the suppliers operated on rather small scale. In fact the most numerous single type of supplier was the private proprietor, often supplying only a few thousand gallons daily (even so the largest of these supplied 171,000 gallons). The fact is that the small waterworks is worthy of consideration on the grounds of the number of such units which existed at this time. To make the point clear, around 27% of local authorities and 89% of private proprietors supplied less than 100,000 gallons daily, and these alone would amount to several hundreds of waterworks. Much of the previous work on waterworks has been directed to the large concerns which were technological leaders in the field, and some consideration needs to be given to the much more numerous suppliers which used a simpler technology.

The Alcester Waterworks Company was such a small supplier, and if a small waterworks is defined as one supplying less than 100,000 gallons daily, then the Alcester Company falls well into this category with a daily supply of 31,000 gallons according to The Return as to Water Undertakings. It is useful to compare the Alcester Company with other companies in terms of magnitude, and this information is presented in tables 1.2 to 1.4 below which are based on *The Return as to Water Undertakings:*

**Table 1.2: The Distribution of Quantity of Water supplied Daily for Companies Operating Under Acts of Parliament**

| Quantity Supplied Daily (thousands of gallons) | Number of Companies | % |
|---|---|---|
| 0-299 | 63 | 44 |
| 300-599 | 22 | 15 |
| 690-899 | 16 | 11 |
| 900-1199 | 10 | 7 |
| 1200-1499 | 4 | 3 |
| 1500-1799 | 4 | 3 |
| 1800-2099 | 4 | 3 |
| 2100-2399 | 4 | 3 |
| 2400-2699 | 1 | 1 |
| 2700-2999 | 3 | 2 |
| 3000 and over | 11 | 8 |
| | Total = 142 | |

**Table 1.3: The Distribution of Quantity of Water Supplied Daily for Companies Operating Under Provisional Water Orders**

| Quantity Supplied Daily (thousands of gallons) | Number of Companies | % |
|---|---|---|
| 0-49 | 15 | 34 |
| 50-99 | 12 | 27 |
| 100-149 | 4 | 9 |
| 150-199 | 3 | 7 |
| 200-249 | 3 | 7 |
| 250-299 | 3 | 7 |
| 300-349 | 2 | 5 |
| 350-399 | 0 | - |
| 400 and over | 2 | 5 |
| | Total | |

**Table 1.4: The Distribution of Quantity of Water Supplied Daily for Companies Operating Without Special Powers**

| **Quantity Supplied Daily (thousands of gallons)** | **Number of Companies** | **%** |
|---|---|---|
| 0-9 | 15 | 33 |
| 10-19 | 8 | 18 |
| 20-29 | 6 | 13 |
| 30-39 | 2 | 4 |

| Quantity Supplied Daily (thousands of gallons) | Number of Companies | % |
|---|---|---|
| 40-49 | 2 | 4 |
| 50-59 | 0 | - |
| 60-69 | 1 | 2 |
| 80-89 | 4 | 9 |
| 90-99 | 0 | - |
| 100 and over | 4 | 9 |
| | Total = 45 | |

**Notes**

(a ) In tables 1.2 to 1.4 the percentages have been rounded off to the nearest percentage point.

(b) The totals differ from the number of companies listed in *The Return as to Water Undertakings* because some gave no details of the quantity supplied daily, merely declaring it to be 'adequate' or 'sufficient'.

Consideration of the tables above shows the preponderance of the smaller suppliers of each type. For the companies operating under Acts of Parliament, it will be seen that 44% of all these concerns supplied less than 300,000 gallons per day while 76% supplied less than 1 million gallons daily. By contrast the largest supplier, the South Staffordshire Waterworks Company was providing over 16 million gallons each day, and the next in order more than 10 million gallons.

Table 1.3 shows where the Alcester Company fits into the scale of things. Supplying 31,000 gallons per day, it lies at the lowest part of the range of the companies operating under Provisional Orders; companies supplying less than 50,000 gallons per day formed 34% of the concerns for which quantitative data are available. Indeed as judged by the quantity of water which it supplied, the Company could well fit in with the smallest category, the companies without powers, the majority of which provided less than 40,000 gallons daily. However it would be reasonable to regard the scale of the operation of the Alcester Waterworks Company to be representative of companies acting under Provisional Orders. Such companies would be expected to be smaller undertakings than those operating under special Acts of Parliament, since the Gas and Waterworks Facilities Act of 1870 which set up the machinery whereby undertakings of this type might derive their powers from Provisional Orders of the Board of Trade, was intended to assist the smaller concerns for which the expense involved in obtaining an Act would not be justified.

The Alcester Waterworks Company was far from typical in the early date of the concern in relation to its size. Table 1.5 shows data relevant to this point, giving the magnitude of various companies acting under Provisional Orders together with their starting dates, taken to be the date of the granting of the order.

**Table 1.5: Dates of Provisional Orders and Quantity of Water Supplied for Companies Operating Under Provisional Orders** (from *The Return as to Water Undertakings*)

| | Period | | | | |
|---|---|---|---|---|---|
| | **1870-79** | **1880-89** | **1890-99** | **1900-09** | **1910-** |
| | 900 | 650 | 80 | 95 | 60 |
| | 300 | 280 | 69 | 90 | 34 |
| | 335 | 214 | 60 | 30 | 24 |
| | 274 | 170 | 50 | 28 | |
| | 250 | 168 | 40 | 20 | |
| | 208 | 138 | 30 | 18 | |
| | 200 | 80 | 19 | 14 | |
| | 180 | 57 | * | 9 | |
| | 130 | 50 | 80 | | |
| | 100 | 42 | | | |
| | 100 | 42 | | | |
| | 76 | * | | | |
| | 31 | | | | |
| Total number of orders made in period | 13 | 12 | 9 | 8 | 3 |
| Average quantity supplied daily | 237 | 159 | 55 | 38 | 39 |

**Notes**

(a) All quantities are given in thousands of gallons.

(b) * denotes a company for which quantitative data are not available

The table shows clearly the tendency for larger companies to have started earlier than smaller ones; this is what one might expect since the potential commercial gains would be more evident for a larger scale operation. The Alcester Company, dating as it did from 1878, fails to follow this trend, for with a daily supply of 31,000 gallons, it fits better into the period after 1900. The table also shows a decrease in the number of Provisional Water Orders issued each year for new companies, presumably since the smaller and therefore later ones represented concerns operating at the margin of commercial success. In fact there is no example in *The Return as to Water Undertakings* of a company operating under a Provisional Water Order which both started earlier than the Alcester Company and was smaller in the scale of its operation in terms of the quantity of water which it supplied each day. All the companies operating under Acts of Parliament which were smaller than the Alcester Waterworks Company started later. It may be that there is an example of a company without powers which was both smaller than the Alcester Company and started earlier, but the information in *The Return as to Water Undertakings* does not enable these companies to be dated. It is at least possible therefore that the Alcester Waterworks Company, in terms of the scale of its operation, was the earliest company of that magnitude in England and Wales.

Thus the Alcester Waterworks Company is worthy of study for two reasons. On the one hand it was unusual in the small scale of its operation in relation to the date at which it started, yet on the other hand representative of the small waterworks in terms of the quantity of water which it supplied. It might be suspected therefore, that some special local factors acted to bring the company into being earlier than might have been expected, and these would be worthy of investigation. On the other hand the technical and financial development of such a concern might give information about the problems and pressures acting upon a small waterworks of the kind which was at one time so numerous.

**Notes and References to Chapter 1**

1. The Dates are those given in Dracup, S. E. ; *Water Supply in Great Britain, 1690-1950, Part I; British Water Supply*, Jan 1973, pp 17-19.
   Dracup gives a good general account of the subject, concentrating on administrative rather technical aspects. For a comprehensive account of the latter on a world-wide basis from the earliest times see *Man and Water : A History of Hvdrotechnology* by Norman Smith. For general background information on the development of technology see A Short History of Technology from the Earliest Times to A. D. 1900 by Derry and Williams is invaluable , while The Century of Science by Sherwood Taylor, is useful for a survey of the interaction between technology and social attitudes in the nineteenth century.
2. Ibid
3. Sherwood Taylor , F. ; *The Century of Science*, Heineman, London, 3rd edition, 1952, p 85.
4. Rolt, L. T. C. and Allen J. S. ; *The Steam Engine of Thomas Newcomen*, Moorland Publishing, Hartington 1977, p 81.
5. Dracup, op. cit. Part II, *British Water Supply*, Feb. 1973, pp. 15-19
6. Derry T. F. and Williams T. I. ; *A Short History of Technology from The Earliest Times to A.D. 1900*; Oxford University Press, London 1960, p.421.
7. Sherwood Taylor, op.cit. , p. 60.
8. Ibid, p. 61.
9. Derry and Williams, op.cit. p.421 is the source for the water yield of the Longdendale scheme. Dracup on the other hand (op.cit. Part 4), quoting *The Return as to Water Undertakings in England and Wales*, states that the scheme was yielding 14 million gallons in 1910.
10. For a summary of the significance of miasmatic and contagionist theories see *Science and Public Health; An Interfaculty Second Level Course - Science and the Rise of Technology Since 1800*. Block 5, unit 10; The Open University Press, Milton Keynes, 1973, pp. 45-50.
11. Dracup, op.cit., Part 3, March 1973, pp. 20-23.
12. Ibid.
13. Sherwood Taylor; op. cit. p.67.
14. Ibid, p. 88
15. Ibid, p.84. According to Derry and Williams (op.cit. p.420) however, cast iron pipes were in use in London and Edinburgh by 1750.
16. Derry and Williams, op.cit. p.421.
17. Ibid, p. 424.
18. Ibid, p. 425.
19. *Science and Public Health* (op.cit. note 10) p. 50.
20. Ibid, p.43.
21. *The Return as to Water Undertakings in England and Wales*; H.M.S.O., 1915.
22. Dracup S.B., op. cit. Part 4, April 1973, pp. 24-27.

## Chapter 2 : Public Health and Private Enterprise

The Warwickshire town of Alcester lies in the lower part of the valley of the River Arrow, about 6km north of that river's junction with Shakespeare's Avon. Near the town the Arrow receives three tributaries. The most important of these is the Alne, which joins the Arrow from the east on the outskirts of the town, while two lesser tributaries, the Spittle Brook and the Rock Mill Stream, rise on the range of low hills to the west, and join the Arrow south of Alcester. The site of the town in relation to **relief and drainage** is shown in the map, figure 2.1.[1]

The Census of 1871 showed that the population of the whole parish of Alcester was 2,363, of whom by far the majority lived in the town itself.[2] In common with other small towns in the Arrow valley, Alcester was a centre for manufacture of needles at this time, although the trade had to some extent moved away to Studley and Redditch. Between 1851 and 1861 for example, the number of persons employed in the trade fell by 16%, although even in the latter year it was still the chief source of employment in the town, with 106 men, 66 women and 36 children engaged in some aspect or other of the process.[3]

As far as public services were concerned, the town in the 1870's was supplied with gas from the works established in 1850, but had neither piped water nor effective sewage disposal.[4] Turnpike roads connected the town with Evesham, Stratford-upon-Avon, Bromsgrove, Droitwich and Wootton Wawen. When railway connection with Evesham to the south, and Redditch and Birmingham to the north, was established in 1866 and 1868 respectively, by what became a branch of the Midland Railway, the roads inevitably declined in importance. The Post Office Directory for Warwickshire in 1872 for example lists no coaches calling at Alcester, although a number of carriers are mentioned.[5] The arrival of the Great Western Railway in 1876, with a branch from Bearley junction on the Hatton-Stratford-upon-Avon line, completed the town's railway services.[6]

The picture we have of Alcester in the 1870's is of a small country town perhaps, somewhat in decline, but still largely self-sufficient, producing most of its own requirements for daily life, and not yet completely within the sphere of influence of Birmingham, its giant neighbour 30km or so to the north.

At this time the body with concern for public health in the Alcester area was the Rural Sanitary Authority. The Public Health Act of 1848 had allowed local authorities to take powers to reform their sanitation, and to appoint medical officers if they wished, but did not compel them to do so. Local Boards of Health could be formed to deal with water supply, sewerage and other matters relevant to public health, and a General Board of Health, one of whose members was the great sanitary reformer Edwin Chadwick, was created to oversee such matters at the national level. Unfortunately the act was not mandatory except in towns where the death rate exceeded 22 per 1000, or where one tenth of the ratepayers petitioned for its adoption.[7]

Partly because of the personal unpopularity of Chadwick, and also because of his belief in a strongly centralized control of public health matters which led to confrontations with vested interests, the General Board of Health was dismissed in 1854, and in 1858 the Privy Council

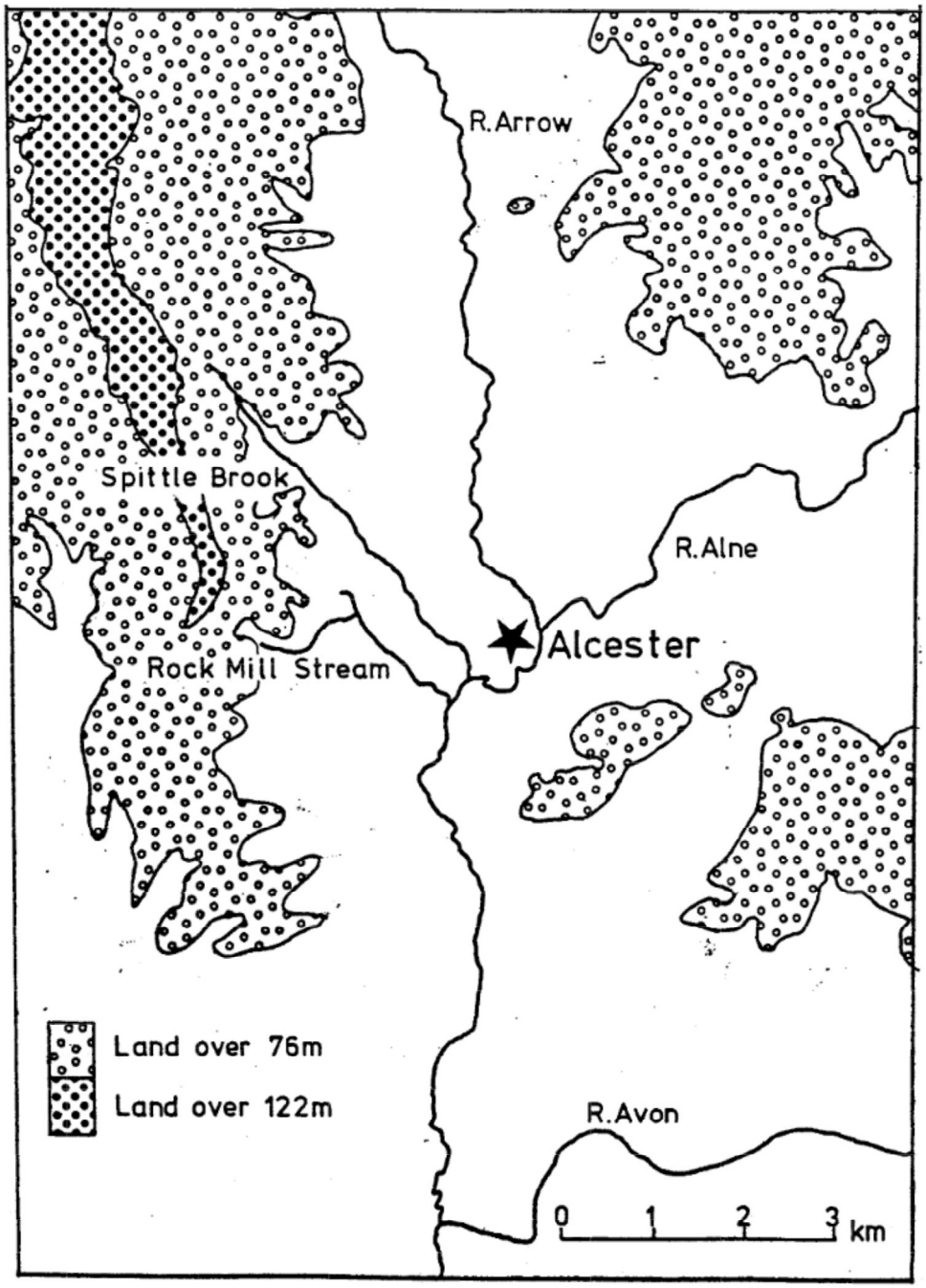


**Figure 2.1 : The Relief and Drainage of the Alcester Area**

was made responsible for public health. The Medical Officer for this body was John Simon, who had acted as the first Medical Officer of the City of London. The Privy Council remained in control until the formation of the Local Government Board under the Local Government Act of 1871. During the period of the Privy Council, Simon made a fundamental contribution to public health by his annual reports as Medical Officer, in which he made known the results of his enquiries into a wide range of problems of environmental disease. Just as the cholera epidemic in Europe of 1847 gave rise to the 1848 act, so the return of the disease for the fourth time on an epidemic scale in

Britain in 1866 led to the Sanitary Act passed in the same year. This imposed upon local authorities the duty of inspecting their districts and suppressing the nuisances found there. Furthermore, legal sanctions were made available to compel negligent authorities to carry out these duties with respect to the construction of sewers and the supply of water, for the Secretary of State and the Court of Queen's Bench were empowered to enforce the neglected duty.[8]

A more considerable consequence of the cholera epidemic was the Royal Commission of 1869-71, which gave rise to the Local Government Act mentioned above, and also to the Public Health Act of 1872, which created urban and rural sanitary authorities, and defined 'nuisances' in towns, factories and workshops. It further introduced compulsion in place of permissiveness – the local authorities were compelled to set up sanitary bodies in both rural and urban areas.[9]

The climax of nineteenth century public health legislation came with the great Public Health Act of 1875, which as a consolidating act drew together all the earlier legislation and codified the administrative framework in which it operated. Chadwick's 'Sanitary Idea' was complete on the Statute Book; all that remained was to implement it.

Alcester's Rural Sanitary Authority, formed as a result of the act of the same year referred to above, held its first meeting in 1872. Its area was identical with that of the Alcester Poor Law Union, a combination of parishes in south west Warwickshire and south east Worcestershire.[10] At this first meeting the Rural Sanitary Authority agreed to negotiate with the Stratford-upon-Avon, Evesham and Shipston Unions about the appointment of a joint medical officer of health,[11] and the minutes of the meeting held, as was the custom, at the Union Workhouse in Alcester, on 24th June 1873 recorded the appointment of both the Inspector of Nuisances for the Alcester Rural Sanitary Authority, and the joint Medical Officer of Health, at annual salaries of £80 and £600 respectively. The Medical Officer was a practictioner from Bidford, G. H. Fosbroke (Jnr.).[12]

The chain of events which, when once set in motion, ultimately provided Alcester with a piped water supply, commenced with the visit to Alcester of Dr. Edward Ballard[13], - Medical Inspector for the Local Government Board, on 23rd. February 1875. The reason for this visit was the smallpox epidemic at that time in progress in the town. The local newspaper, *The Alcester Chronicle*,[14] reported eighteen cases of the disease in the town on 23rd January 1875, and on 12th of January the Rural Sanitary Authority discussed, with the Medical Officer of Health, the proposal for the provision of a sanatorium for the isolation of smallpox and other infectious diseases. The Medical Officer suggested the building of a permanent hospital, but the Clerk to the Rural Sanitary Authority frowned upon this as likely to be too expensive.[15] Ultimately a temporary sanatorium was established in the town in a disused needle workshop.[16]

In addition to enquiring into the smallpox outbreak, Dr. Ballard investigated other matters in the town, particularly the drainage and water supply, and addressed the Rural Sanitary Authority about the sanitary state of Alcester on the same day.[17] His comments were forthright, and distinctly unfavourable. According to the Alcester Chronicle, Dr. Ballard was of the opinion that 'Practically ..... there were no sewers at all'.[18] Clearly he had been conducted about the town by Fosbroke, who had drawn his attention to the 'bottomless places . . . . which were called sewers; but

they were not sewers, and anything passing into them must soak into the soil, and there was danger of it getting into the wells'. The Medical Inspector concluded his remarks about the sewerage by urging the Rural Sanitary Authority 'to take immediate action by consulting an engineer and obtaining plans for the proper sewerage of the place.'

Turning to the water supply, Dr. Ballard described the wells from which the inhabitants drew their water as 'neither deep nor shallow, the majority being about 14 feet deep'. But he described the water as having soaked from the soil 'polluted with mess from privies and drains, the latter being in many instances close to the wells.' He went on to warn the Rural Sanitary Authority of the possibility of an outbreak of typhoid fever in these circumstances: 'a case might come in and be communicated from privy to well until it spread throughout the town'. It is clear from these remarks that Ballard had a clear grasp of the mechanism whereby typhoid fever might be spread, namely by persons drinking water which had been contaminated by faecal matter from those infected with typhoid.[19] He went on to recommend the Rural Sanitary Authority to consult an engineer about the provision of water supply, preferably from outside the town, and stated that he had been told that water could be obtained from the hills nearby and supplied to Alcester at a moderate cost. [20]

In his report to John Simon, head of the Medical Department at the Local Government Board[21], Dr. Ballard makes it clear that he had relied extensively on a report on the sanitary state of Alcester produced by Fosbroke, the joint Medical Officer of Health for Alcester, a copy of which remains in the Public Record Office with Ballard's own report.[22] Fosbroke's report was prepared for the Rural Sanitary Authority and presented to that body on 15th September 1874. After a brief description of the parish of Alcester and its geological environment, the report presents an analysis of the Death Register for the town of Alcester from 1869-73. This is reproduced in Table 2.1 below:

**Table 2.1 (a): An Analysis of the Death Register for the Town of Alcester for the years 1869-73**

| | **Date** | | | | |
|---|---|---|---|---|---|
| **Estimated Population** | **1869** | **1870** | **1871** | **1872** | **1873** |
| Total deaths (all causes,all ages) | 46 | 47 | 38 | 50 | 37 |
| Deaths per thousand of population | 19.9 | 20.1 | 16.0 | 21.0 | 15.3 |
| Deaths under 1 year old | 31 | 36 | 28 | 36 | 28 |
| Deaths at 1 year & above | 31 | 36 | 28 | 36 | 28 |
| **No. of deaths registered as due to the undermentioned causes** | | | | | |
| Fever* | | 1 | | 2 | |
| Smallpox | - | - | - | - | - |
| | **1869** | **1870** | **1871** | **1872** | **1873** |
| Scarlet fever | 4 | | | 4 | 2 |
| Diarrhoea | 3 | 3 | 3 | 1 | - |

| | | | | | |
|---|---|---|---|---|---|
| Pthisis | 4 | 9 | 3 | 7 | 6 |
| Convulsions | 2 | 2 | 2 | - | 1 |
| Measles | - | - | - | 4 | |
| Diphtheria | - | - | - | - | - |

* The term ‘Fever’ has here the same meaning as that given to it in the Registrar General’s Reports.

(From the report to the Alcester Rural Sanitary Authority by its Medical Officer of Health, 15th September 1874)

**Table 2.1(b): A comparison of the Infantile Death Rates of Alcester with those of England and Wales as a Whole**

| Date | Locality | Population | Deaths under 1 year | Deaths per 1000 living at all ages |
|---|---|---|---|---|
| 1869 | England & Wales | 21,869,607 | 120,274 | 5.5 |
| | Alcester | 2,312 | 15 | 6.4 |
| 1872 | England & Wales | 23,074,600 | 123,258 | 5.3 |
| | Alcester | 2,386 | 14 | 5.8 |

(From the report to the Alcester Rural Sanitary Authority by its Medical Officer of Health, 15th September 1874)

The figures in Table 2.1 show that Alcester's total death rate over this period varied from 15.3 to 21.0 per 1000 of population with an average value of 18.4 per 1000. The latter figure may be compared with a general death rate far the country as a whole for the period 1871-75, which averaged 20.8 per 1000[23] ; since this included of course the very worst areas, it does not reflect very well upon the state of public health in a relatively small and isolated country town. Part of this high total death rate was due to the disproportionately high infant mortality rate in the town. Fosbroke's report gives figures for the death rate of infants under 1 year, per 1000 living at all ages, for 1869 and 1872, as 6.4 and 5.8 respectively as compared with national figures of 5.5 and 5.3. The Medical Officer of Health commented ‘in a country district like Alcester it should be below the average’.

As far as the causes of death are concerned, the town seemed to be remarkably free of infectious disease; Table 2.1 shows an absence of fatalities from smallpox, and diphtheria, and only three deaths from fever (the term included typhoid, cholera and simple continued fever) The greatest single cause of death is shown to be phthisis (lung complaints of various kinds),[24] among the classified infectious diseases, although it is important to note that total deaths from these causes in the town averaged only 28.9% of all deaths over the period 1869-73. Certainly it is clear that Alcester had little experience of typhoid or cholera, the diseases primarily associated with poor sanitation and water supply.

Fosbroke goes on in his report to describe the sewerage and water supply. It appears that ‘with but few exceptions each house or block of houses was provided with a drain of some kind or

other' and that they were 'connected with the so-called street-sewers.' The Medical Officer of Health comments unfavourably upon the untrapped nature of these house drains, which allowed the sewer gas to enter the houses easily. This of course was a common feature of the domestic situation in the nineteenth century. F. Sherwood Taylor quotes 'a writer of the eighties' as remarking:[25]

> If a prince for the outlay of about £40,000 obtains a house that is practically little better than an ornamental sewer-gas factory, what sort of pest-house can one expect to rent at from £50 to £100?

However, Fosbroke clearly believed that as well as aesthetically unpleasing, the smell of sewer gas was actually harmful, for he comments :

> Of the injurious results of inhaling sewer air, I need not make mention, as it is a well established fact that such is often the cause of serious outbreaks of fever, from which the town of Alcester appears to have hitherto miraculously escaped.

From this it is clear that The Medical Officer of Health was a supporter of the miasmic theory of disease.[26] His description of the street sewers states that there were two main drains, one laid down the High Street, and another that met it near the Stourbridge Bank. These are described as 'simply a brick arch over turned over an earth bottom', and apparently discharged eventually into an offensive ditch near the bottom of Bleachfield Street and thence into the River Arrow.

As well as these main sewers there were a number of minor ones, some constructed in a similar manner, but others consisting of common draining pipes, as little as four inches in diameter. It is clear that sewers without a bottom course impermeable to water will allow their contents to leak into and contaminate the soil with sewage. In an area such as Alcester where the wells were shallow and drew the water from the subsoil,[27] the risk of pollution is considerable, and Fosbroke adds a comment to this effect. In conclusion he recommends that the Rural Sanitary Authority should attend to the improvement of the drainage of the town which 'is not in a satisfactory condition'.

Turning to the water supply, Fosbroke comments upon the private wells which formed the sole source of supply, and draws attention to the proximity of the wells to privies and cesspits, quoting one instance in the High Street where 'the receiving pit of a water closet is sunk within one yard of a well'.[28] Provided that the garden of the premises is large enough to allow the well to be sunk at some distance from the midden or cesspit however, Fosbroke regarded the water as likely to be wholesome. He makes no specific recommendation for the improvement of water supply in the town save for the closing of wells known to be polluted.

The effect of Dr. Ballard's report, coming as it did from the Local Government Board, the very citadel of public health, was considerable. Steps were taken, soon after the meeting which Dr. Ballard attended in February 1875, to form a Local Board of Health, that is to have Alcester constituted as Urban Sanitary Authority, independent of the existing Rural Sanitary. Authority. This application was refused by the Local Government Board in a letter whose receipt was min-

uted on 10th May 1875. The grounds given for refusal were the small population of the town. However the Rural Sanitary Authority, on the prompting of the Medical Officer of Health, Fosbroke, had applied for 'Urban Powers', to deal with nuisances, in December 1874 and these were granted on 29th June 1875.

Dr. Ballard's report was not officially received by the Sanitary Authority until 1st June 1875, although of course the substance of its contents was known from the publicity given to Dr. Ballard's comments in *The Alcester Chronicle*. The members of the Sanitary Authority at the meeting on 1st June 1875 resolved 'to consult a Civil Engineer to report on the town' [29], and the man chosen was 'Mr. Pritchard of Warwick'.[30] By 29th June the Clerk of the Rural Sanitary Authority was able to report that he had seen 'Mr. Pritchard C.E. of Warwick, in connection with the provision of improved drainage and water supply for Alcester.'[31] The engineer wasted little time, for on 27th July the Clerk (Langston Jones) was able to present a preliminary report to the meeting of the Sanitary Authority. [32]

On the 2nd. of November 1875, Pritchard was able to present his plans in person to the Rural Sanitary Authority[33], and they were reported in detail in *The Alcester Chronicle*.[34] Two schemes were described; one was to supply the town with wholesome water, while the other provided the town with effective drainage. The water schemes involved the abstraction of water from Spittle Brook, some distance from Alcester and at sufficient height above it to allow the water to gravitate to the town. The water was first to be stored in a reservoir of 600,000 gallon capacity, then filtered before being piped to the town. The head of water in the centre of Alcester was to be at least 106 feet which would allow water to reach the tops of the tallest buildings from fire hydrants without any need for fire engine pumps. The location of the works is shown in figure 2.2.

The report in *The Alcester Chronicle* includes two analyses of the water from Spittle Brook, and Pritchard's comments on these results show that the water was thought to be of sufficient purity for supply to the town; probably a modern analyst would be of the same opinion, although criteria of water pollution have changed since the 1870's. Both analyses are reproduced in table 2.2 below.[35]

**Table 2.2: Analyses of the Water of Spittle Brook by Mr Cutling of Leamington and Dr. Hill of Birmingham (from The Alcester Chronicle, 6th November 1875)**

| **Mr Cutling's analysis, 26th July 1875** | **Grains per gallon** | **Parts per Million** |
|---|---|---|
| **Total Solid Residue :** | | |
| Chlorium 1.26 | 31.10 | 444.0 |
| Chloride of sodium | 2.07 | 29.56 |
| **Hardness by Clarke's test** | | |
| Temporary hardness | 14.20 | 202.8 |
| Permanent hardness | 11.60 | 165.6 |
| Nitrates & Nitrites | A minute trace only | |
| Free or saline ammonia | 0.02 | 0.286 |

| | | |
|---|---|---|
| Albumenoid ammonia (ammonia from organic matter) | 0.07 | 0.999 |

| **Dr Hill's Analysis 29th September 1875** | **Parts per 100,000** | **Parts per million** |
|---|---|---|
| Total solid impurity | 43.02 | 430.2 |
| Organic carbon | 0.100 | 1.00 |
| Organic nitrogen | 0.045 | 0.45 |
| Ammonia | 0.004 | 0.04 |
| Nitrogen (as nitrates & nitrites) | 0.090 | 0.90 |
| Total combined nitrogen | 0.138 | 1.38 |
| Previous sewage contamination | 610 | 6100 |
| Chlorine | 1.42 | 14.2 |
| Permanent hardness | 20 degrees | - |

**Note :** The figures in the right hand column have been derived from those in the left hand columns for ease of comparison.

In response to a question from the Marquess of Hertford,[36] concerning the sufficiency of the possible supply from Spittle Brook, Pritchard claimed that his gauging of the stream indicated that ample water would be available, and that a test in June 1875 showed that 25,000 gallons of water flowed down the brook in twenty-four hours, at a period of the year when the flow rate might be expected to be at a minimum. The capacity of the reservoir was such as to constitute twenty-six days supply at the estimated rate of consumption.[37] Thus according to Pritchard's figures the lowest daily yield of the Spittle Brook was slightly greater than the town's requirement. As far as purity was concerned, Pritchard claimed that the Spittle Brook water was of greater purity than that being supplied to the town of Warwick.[38]

He estimated the cost of the scheme, exclusive of land purchase and legal expenses, but inclusive of an allowance for surface damage at £3,035-19-4. He further suggested that the water might be charged for by two methods, large consumers having their supply metered, and small consumers being charged by their rateable value, and claimed that making a charge for the water would tend to discourage wastefulness.

In accordance with his instructions from the Rural Sanitary Authority, Pritchard had also produced plans for sewering the town. Alcester, because of its low site close to the Arrow, into which river all the effluent must ultimately be discharged, presented something of a problem to a sanitary engineer. For in order to provide an adequate down-gradient in the sewers – needed to give a flow rate large enough to scour away any solid deposits, and make the sewers self cleansing - it was necessary to make the outfall level very close to the river level, indeed below it in time of flood, while the upper ends of the sewers would be very close to the surface of the ground. Even so Pritchard found it impossible to provide some branches with the ideal gradients, and these were to be provided with special flushing chambers, supplied from the proposed water system.[39]

As presented to the Rural Sanitary Authority, Pritchard's sewerage scheme provided for

two twelve inch (0.305m) outfall pipes, one draining the Maltmill Lane – Gas House Lane area while the other would pass under Priory Street and Swan Street, the two forming a junction under Stratford Road. A single pipe, also twelve inches in diameter, would lead from this junction to the outfall on the west bank of the Arrow. These main pipes were to be joined by lesser sewers nine inches in diameter, to which in turn the house drains would be connected, so that the entire system would use 1217 yards of the larger size of pipe and 3104 yards of the smaller.

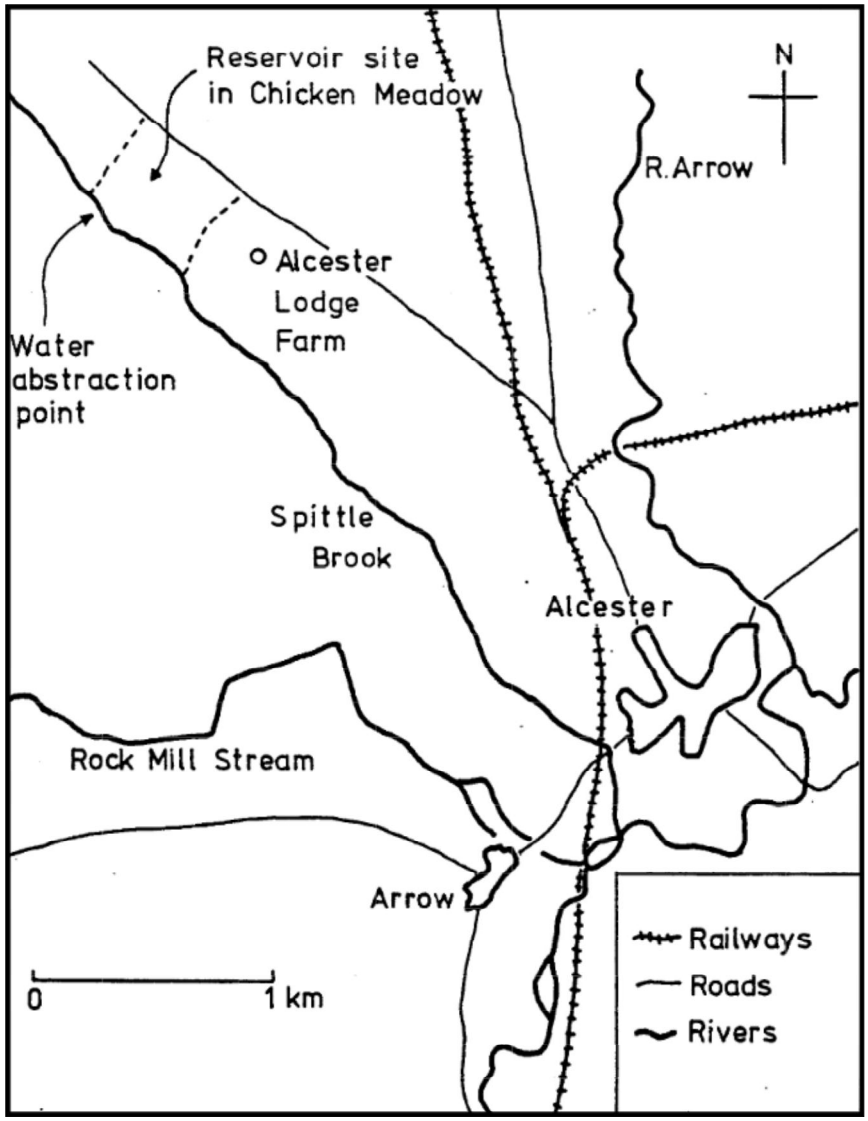


**Figure 2.2 : Pritchard's Alcester Water Scheme, 1875**

The effluent was to be disposed of on land prepared for that purpose, and was to be conveyed to it from the outfall pipes by 'underground carriers' for distribution through 'small open chambers,' the effluent eventually passing into the River Arrow. Pritchard claimed that 'By this process the sewage will be purified and utilized in the most complete manner.'

The engineer's estimate for the cost of the sewerage and sewage disposal scheme at £2,180-7-8d, making a grand total of £5,216-7s for both water supply and sewerage. This com-

pleted Pritchard's exposition of the schemes and *The Alcester Chronicle* comments that 'considerable discussion then took place upon the plans.' Well it might, for the engineer was suggesting the expenditure of a considerable sum of money by a small and by no means prosperous town. However, most of the points raised (as reported by The Alcester Chronicle) concerned the efficiency of the proposed sewerage scheme rather than the costs.

It would appear that the Marquess of Hertford was rather dubious about the use of gravity to dispose of the sewage, for he asked why the engineer had not designed a scheme for pumping the sewage, and received the reply that this was done to avoid expenditure.[41] When questioned about the level of the sewage outfall being below river flood level, Pritchard maintained that the disposal area had not been inundated in the recent flood, and that in any case the flood water might be kept out by means of an embankment. Even if flooding did occur there would be no objection to sewage passing down the river in flood times.[42]

The meeting of the Rural Sanitary Authority concluded with a decision to adjourn consideration of the plans, so as to enable the engineer to complete copies of them for inspection by the Guardians and principal ratepayers.

The Marquess of Hertford, besides his interest in the schemes of sewage and water supply, which resulted from his membership of the Rural Sanitary Authority, was also involved in a private capacity. As the principal landowner in the area he was bound to have an interest in the outcome of Pritchard's proposals. The reservoir and associated works for the water scheme would have been constructed entirely on his land, as would the works for sewage disposal. Furthermore, the Marquess would have been liable to pay heavily for the schemes through the poor rates, should the Rural Sanitary Authority decide to implement them.

Possibly with this prospect in view, the Marquess had, as early as 24th August 1875, proposed to the Rural Sanitary Authority the resolution :

> That having regard to the drainage and sewerage works and water supply required for improvement of Alcester, it is expedient that the town of Alcester be constituted a Special Drainage District, and that application be made to the Local Government Board for their sanction to it.

This resolution was duly passed.[43]

In the event of such a Special Drainage District being constituted the cost of the water and sewerage schemes would have been borne by the ratepayers within the district, rather than all the ratepayers of the parish. Thus while being prepared to help the schemes in any way he could, the Marquess was disinclined to bear the brunt of the costs of providing services from which neither he nor most of his tenant farmers could benefit.

As well as setting the campaign for a Special Drainage District in motion, Lord Hertford also began to make his own enquiries about Pritchard's schemes. In particular he wrote to a Mr. Menzies,[44] also an engineer with experience of sanitary matters, to ask for comments on Pritchard's proposals. Menzies's reply indicated little enthusiasm for 'subterranean irrigation, that is the discharging of effluent from small pipes below ground level', which was the basis of Pritch-

ard's method for disposal of the sewage.[45]

Further unfavourable comment came from Mr. Randell, the Marquess's agent, who suggested taking the opinion of a second engineer and, failing this, that the sewage question should be 'left in abeyance', presumably to continue with the water scheme. Randell also commented: 'I cannot believe that Alcester's sewage is to be got rid of other than by pumping'.[46] In this he was partly correct; Alcester's sewage was in due course disposed of by pumping rather than gravitation. Randell also drew attention to the fact that Pritchard's scheme provided a reservoir for the storage of unfiltered water but no storage for filtered water, the consumer's supply presumably to be drawn directly from the filter beds. This appears to be a reasonable objection, for the water supply would be in serious difficulties if the demand from the consumers exceeded the rate at which water could be drawn from the filter beds. On the other hand the supply from the Spittle Brook was by no means abundant, so that the provision of a holding reservoir, as Pritchard planned, was essential. No doubt the expedient of providing two reservoirs, one above the filter beds and one below, was rejected by the engineer on the grounds of expense.

While Lord Hertford was pursuing these enquiries of his own, opposition to the improvement schemes, or more precisely to their cost, was rising in Alcester. On 20th November *The Alcester Chronicle* published a notice from the High Bailiff, convening a meeting of ratepayers of Alcester to discuss the plans for drainage and water supply.[47] The meeting was held in the Town Hall on 23rd November, and duly reported in the local newspaper on 27th November. As well as Pritchard himself, Fosbroke (the Medical Officer of Health), Langston Jones[48] and Lord Hertford, the newspaper reported 'a very large attendance.' The High Bailiff took the chair (on the suggestion of the Marquess of Hertford) and introduced the topic for discussion, referring to Dr. Ballard's report and its recommendations, the unsuccessful attempt, to establish a Local Board of Health, and consequent devolution of responsibility for the work upon the Rural Sanitary Authority. Mr. Pritchard's plans had been prepared as a result and those in attendance were invited to comment upon them. The chairman stressed that they were not to decide whether the work was to be done or not, for the improvements had to be made whatever the cost; they were to decide whether the plans were 'such as would thoroughly and effectually accomplish the work', and the opinions of those who had practical knowledge of the subject were invited. The chairman concluded his remarks with the hope that 'any suggestions would be substantiated by good reasoning, because the Government would not listen to objections made merely for the purpose of getting out of expense.'[49]

The Marquess of Hertford spoke first after these introductory remarks, drawing the attention of the meeting to the fact that the Rural Sanitary Authority had:

> power to decide upon the plans without consulting the ratepayers, but with the doubt there was as to the feasibility of Mr. Pritchard's plans they naturally preferred . . . . to call attention to the subject and get their opinions on it (applause ).[50]

The Reverend M. Philpin[51] at once asked:

> Are we bound to have both the drainage and the waterworks? (Hear! Hear!). Had they

> no voice in the matter? Were they simply asked to come there and examine Mr. Pritchard's plans and still have no voice in the matter?

(The newspaper here records further cries of Hear! Hear! and applause). At this point Langston Jones, the Clerk to the Rural Sanitary Authority, reminded the Reverend Mr. Philpin that Dr. Ballard's report had alluded to both the drainage and the water supply, and that means had to be found for meeting both (Hear! Hear! from Lord Hertford), and that both were essential. Langston Jones went so far as to threaten the meeting that 'if Dr. Ballard 's report were not acted upon, the Local Government Board would step in and do such work as they thought necessary irrespective of the expense to the ratepayers'.[52]

Mr Philpin retorted in spirited fashion questioning the necessity of the proposed water scheme, and suggesting that Pritchard's estimates of the costs would turn out to be too low.[53] He contended that 'they' (presumably the Rural Sanitary Authority ) should do the drainage if they liked and 'let them be compelled to do that whether they liked it or not, but not the water scheme (applause)'.

The Marquess of Hertford then cooled the atmosphere somewhat by suggesting that the engineer be allowed to explain his proposals before 'any more motions were made'. Pritchard then described his schemes, stating that his attention had been directed chiefly to 'economy combined with efficiency', and mentioning pumping as an alternative to gravitation for sewage dispersal. He emphasised the economy of a scheme based gravitation. In reply to Philpin's remarks Pritchard stated it to be his opinion that 'it was absolutely necessary that the waterworks should be taken into consideration in conjunction with the sewage', giving among his reasons the difficulty of preventing percolation from the drains and the use of the water for flushing the sewers.[54]

The Marquess of Hertford now diverted the attention of the meeting to the medical aspects of the situation. The Chairman gave it as his opinion that the polluted water supply was a greater danger to health than the poor state of drainage and more likely to lead to an outbreak of typhoid.[55] No doubt the Marquess found this reply very acceptable, since he (advised by Randell) was inclining to leave the sewage question 'in abeyance.'[56]

The Marquess then announced that as far as the Spittle Brook water was concerned 'he had no wish to charge them one farthing for it' (applause), and would charge the usual agricultural rent for the land to be used for sewage disposal.[57] This was quite a generous gesture on the part of Lord Hertford, for he could have made a heavy charge for the right to take water had he wished, and possibly made the water and sewage schemes very expensive in other ways.

The ratepayers opposed to the schemes soon returned to the attack however, with a renewal of Philpin's proposal to improve the drainage, and thereby make the water supply from the wells acceptable. Several views were expressed in support of this idea, some speakers even being prepared to go to the expense of pumping in the cause of efficient sewage disposal. However, the Chairman made it clear once again that Dr. Ballard had indicated that sewering the town would not be enough, and illustrated the point by referring to the polluted state of the well-water supplied to cottages in the ownership of the Reverend M. Philpin himself; this water was believed to be impli-

cated in the case of typhoid fever reported amongst the inhabitants of the cottages.

This appears to have angered the Reverend gentleman somewhat, for a heated exchange ensued between him and the Chairman. Philpin pointed out that during the fifteen years of his ownership only three persons had died in this property, none of them from fever. 'Surely' he asked the meeting, 'that water could not be so radically bad?' (applause). Several other speakers referred to the 'splendid nature' of the water in Alcester, judging no doubt by its clarity, smell and taste.[58] What all these, including Mr. Philpin, failed to understand was that the water could still be a potential source of infection even if apparently pure. For, as long as matter from cesspits and privies found its way into the wells, all that was needed for an epidemic of typhoid to spread rapidly through the town was the presence of a person carrying the disease. On the other hand it must be remembered that in the late 1870's the science of microbiology was in its infancy, and even medical men of some eminence differed on the mechanism by which typhoid fever was spread, so it is scarcely surprising that the townspeople could not readily understand the danger of a polluted water supply, or even agree that it was polluted. They had drunk the water for years without ill effect, and failed to see why they should not continue to do so. The foul sewers they could see and understand, whereas the polluted water might be, for all they knew, a figment of the scientific imagination.[59]

The Marquess of Hertford once again drew technical matters to the attention of those present, by confronting Pritchard with Mr. Menzies's opinion that the town could not be drained effectively without pumping, and commenting upon the unfavourable levels at the outfall. He concluded by suggesting that the opinion of an independent engineer be sought and stated that 'he was afraid that they could not do it without pumping, but it might not be found necessary, and the gentleman they might call in would give them his opinion whether the scheme before them was possible or not'

A more extreme view was expressed by a Mr. Walker, who contended that the water from Spittle Brook was unsuitable, 'being too hard for washing purposes and unfit for drinking purposes, as it would have a tendency to produce stone in the bladder, dyspepsia and goitre', giving as his authority for this opinion that 'a friend had told him from the analysis.'[60] Walker further suggested that the introduction of sewers would 'spoil the present water', (presumably because excrement and foul water which had hitherto been more or less isolated in brick lined pits would be flowing through the town in the proposed sewers. He recommended earth closets. Pritchard, in replying, agreed that the well water would be jeopardized by the sewerage scheme, but gave this as a reason for introducing the water scheme. He maintained that the Spittle Brook water compared favourably with that supplied to London, Birmingham and Manchester. Eventually a motion was proposed to the effect that:

> This meeting respectfully recommends to the Sanitary Authority that Mr. Pritchard be requested to perfect his plans and scheme, and that when he has done so, they should consult a disinterested engineer upon them, particularly with a view of ascertaining if a complete system of drainage when carried out will not obviate the necessity for any water

scheme for the town.

The Reverend Mr. Philpin seconded this motion, and emphasised the expensive nature of the schemes proposed, but was reprimanded for this by the Marquess of Hertford who reminded him that they had to deal with gentlemen 'who did not look to expense but to the health of the country.' After further exchanges between Philpin and Lord Hertford, the motion was carried, and the proceedings brought to a close.

The account of the meeting is of interest because it illustrates the strong, although divided nature of the opposition to the Rural Sanitary Authority's schemes of improvement. What might be termed Lord Hertford's party was opposed to the sewerage scheme on technical grounds, but in favour of the proposals for water supply, and prepared to assist either, or both schemes under certain circumstances. The body of opinion which had the Reverend Mr Philpin as its most vociferous protagonist was wary of the expense of the proposals, and favoured improving the drainage and abandoning the water scheme, presumably because this was the more costly of the two. A third, more extreme view was that represented by Mr. Walker; the members of this party considered that the sanitary arrangements of the town should be improved by abandoning all water closets and other forms of privvy which allowed leakage into the soil, so that the well water would become wholesome, thus allowing both drainage and water schemes to be shelved.

The motion which was passed reflected the ideas of the Philpin faction more than the others and this tends to suggest that this body of opinion included most of those present at the meeting, and by implication most of the ratepayers of Alcester Town.

This meeting of the ratepayers was described in The Alcester Chronicle on 27th November 1875, although it took place on the 23rd. Published in the same edition of the newspaper was a letter from Langston Jones:

To the Editor of The Alcester Chronicle :—

Sir, - Since the public meeting on Tuesday last, an alternative scheme has suggested itself to me and others, viz., to supply the town with water as proposed by Mr. Pritchard and to initiate a thorough scheme of scavengering and privy accommodation by which means the drains, middens and cesspools will be regularly emptied and kept cleansed.

This scavengering system would be attended with but little expense, and several gentlemen to whom I have mentioned the subject, and who are all more competent to form an opinion on it than I am, think with me that if effectively carried out it would obviate the necessity of the proposed sewerage works.

The estimated expense of the water supply is £3,035 and if the water be paid for by the consumers, as in large towns, the annual expense attending the original outlay would be virtually recouped.

I write quite unofficially and simply as a ratepayer with the view of inviting public opinion on the matter, and I am, Sir, your obedient servant.

November 26th, 1875 J. Langston Jones

This letter embodied the elements of quite a considerable compromise, possibly aimed at appeasing the ratepayers who feared the expense of the dual schemes, while retaining the water supply, believed to be more important from a public health point of view. The originators of the scavengering scheme are unknown, apart from Langston Jones himself, but there is reason to believe that they included at least some of the medical men of the town.[61] The principle of scavengering was the removal of excrement in solid form from earth closets, by men employed by the Rural Sanitary Authority. No other form of closet was to be allowed and all existing water closets and privy middens, which mixed slop water with excrement, were to be sealed off. By this means it was hoped the contamination of the soil might be avoided.

Pritchard soon prepared his revised plans as instructed, and presented them to the Rural Sanitary Authority on 18th January 1876.[62] The plans for water supply and disposal of sewerage by gravitation were unchanged, but in addition the engineer presented plans for sewerage disposal by pumping, and for scavengering the town, as requested by the Rural Sanitary Authority.[63] Steam power was proposed for the pumping with 'engines and pumps in duplicate . . . . also engine and boiler house and house for attendant.' The cost of this new scheme was estimated at £5,066-8-4d.., or more than double that of the gravitation scheme at £2,180-7-8d. Pritchard described the scavengering scheme very briefly. The intention was to retain the existing sewers and outfalls and use the new water supply to flush them. All water closets and cesspools draining into the sewers would be sealed off, and the privies reconstructed on the earth closet system. Thus the sewers would carry only storm and 'slop' water (i.e. refuse water from sinks etc.). Excrement was to be removed from the earth closets at regular intervals by men in the employment of the Rural Sanitary Authority. The engineer commented unfavourably upon the scavengering idea, quoting the River Pollution Commissioners on the sewage from Broadmoor Lunatic Asylum: 'It seems hopeless therefore to anticipate any substantial reduction of sewage pollution by dealing with solid excrementious matters only.' The point was of course that unless a proper sewerage scheme was installed in the town, the River Arrow would still be polluted by objectionable refuse water, and the solid excrement would have to be disposed of in some way; it could not simply be tipped into the river.

In the ensuing discussion, Pritchard was asked to give an estimate of the scheme of scavengering, and stated that 'the plant would be the only cost' (presumably the plant for the disposal of the solids) since the reconstruction of the privies would be the duty of the property owners who would therefore bear the expense. Lord Hertford and Pritchard agreed upon the unfavourable opinion which the Local Government Board had of scavengering schemes, and Pritchard gave it as his opinion (in reply to a question from Lord Hertford ) 'that if they (the Rural Sanitary Authority) adopted it there was not the slightest chance of their (the Local Government Board) passing it and that 'a good water supply in the town might effect a delay, but an efficient drainage system was in the end inevitable.'

Support for scavengering came from its chief protagonist, Langston Jones, who declared that the opinion of 'the medical gentlemen of the town' was that 'water supply with scavengering would keep the town healthy'; the Clerk thought that these opinions would carry weight with the Local Government Board. The Chairman of the Rural Sanitary Authority contended that 'if they

got rid of the water closets the deleterious matter sent down the drains would not pollute the river to any objectionable extent.'

In reply to a further question from the Marquess of Hertford, asking whether there was anything to recommend the scavengering scheme, Pritchard maintained that the Local Government Board would not sanction such a scheme and stated that 'the only way he could see of doing it was to adopt it without showing it to them, and get their approval to the water scheme.' The Chairman was of the opinion that if the town was supplied with good water and the death rate lowered to an acceptable level, the £5,000 which might be spent on the sewerage scheme would be a waste of money. Pritchard countered this by pointing out that the scavengering scheme might do. while the town was healthy, but if an epidemic broke out the sewerage scheme would be needed.

Lord Hertford now pressed the meeting to decide between the schemes, contending that the gravitation scheme was unlikely to be efficient so the decision was to be between pumping and scavengering. Eventually a resolution was passed in favour of the scavengering scheme[64] and Lord Hertford then presented the conditions upon which he was prepared to allow abstraction of water from the Spittle Brook declaring that 'he was very anxious to see the town of Alcester supplied with good water at as cheap a rate as possible.' The conditions were thought liberal, for the Chairman said that 'they ought to express their thanks to him - (Lord Hertford; No!, No!) - for meeting them in such a kind way' In due course a resolution was passed approving Pritchard's water supply scheme, and the Clerk was instructed to forward the plans of this scheme to the Local Government Board for their approval.

Thus the Rural Sanitary Authority committed itself to a sanitary improvement scheme which in the opinion of its engineer was unlikely to be approved by the Local Government Board, and to a scheme for water supply which was viewed with hostility by a substantial number of the ratepayers of the town. Letters expressing opinions against both scavengering and water schemes together with rejoinders from Langston Jones, had been published by *The Alcester Chronicle* and these exchanges are perhaps indicative of the feelings generated in the town by these events.[65]

Having made its decision, the Sanitary Authority took no further action for some time. On the 14th March 1876 however, the Clerk was instructed to indicate, by a notice in *The Alcester Chronicle*, the Authority's intention to construct the reservoir for Pritchard's scheme.[66] The notice duly appeared in the edition of the newspaper for 18th of March[67], and possibly provoked the small rush of hostile letters which were subsequently published in the paper. Evidently the hostile feeling rose to a head, for on 12th April a 'meeting in opposition to the proposed waterworks' was held in the town, and the details of what transpired were subsequently reported in The Alcester Chronicle.[68] The Reverend M. Philpin took the chair, and lost no time in proposing the first resolution himself:

> That this meeting views with extreme alarm the intention of the Rural Sanitary Authority to borrow a large sum of money on the property of the inhabitants of Alcester to construct a reservoir and other works, and it will use all legal means to prevent the money being obtained.

In his address, Philpin contended that the water scheme was :

> unnecessary and an evil. Nature had supplied Alcester with an abundance of good water, and all that was needed was attention to the drains. Remove these causes of contamination and it was his impression that they would then have good water - (Hear!, Hear!).

After declaring that the cost of the works would be ‘double the engineer's estimate’, and that the rate increase would lower the rents of property in the town, Philpin concluded by moving the resolution. This evidently echoed the sentiments of those present, for it was seconded and carried unanimously. Further resolutions in a somewhat similar vein were soon passed, one of which favoured the improvement of the public drains, together with the introduction of earth closets (but not a new water supply of course), and scavengering. The meeting decided to send copies of the resolutions to the Rural Sanitary Authority, and turned its attention to consideration of the water scheme in detail, having first demolished it in general.

Philpin once more led the way here, claiming to have a petition signed by 200 ratepayers against the application to borrow money for the works, with only ten persons refusing to sign (these nonetheless maintaining that the works would ruin them). From the report in *The Alcester Chronicle* Philpin seems to have become rather intoxicated by his own oratory at this point. He went so far as to state that if the Sanitary Authority or the Local Government Board ‘would force things upon them of this kind so thoroughly against their will it would be one of the most despotic pieces of despotism anywhere in the world (applause).’ As if this rather extreme claim were not enough, he went on to utter dark threats of what might be interpreted as armed rebellion, stating that ‘they must not allow themselves to be crushed without showing that they would resist and with all their might (loud applause).’

After this heady stuff, attention turned to more mundane matters, with various speakers condemning the water of the Spittle Brook as insufficient, if not poisonous, and maintaining that cleansing the wells would make their water good. Several well owners testified to the excellence of the supply which they enjoyed after cleansing their own wells, but a note of dissension was struck by a former tenant of Park Farm who had used the Spittle Brook nearby as his supply for twenty-four years and 'would not say one word against it.' However, even this speaker agreed that the Spittle Brook would be insufficient for the task of supplying the town.

Other statements along similar lines were made, but no new technical grounds for opposing the scheme emerged, and after congenial votes of thanks all round, the meeting closed. However exaggerated the opinions of the Reverend Mr Philpin and insecure the townsmens’ grasp of sanitary principles it is clear that the opposition to both water and sewerage schemes was considerable, and likely to provide embarrassment for the Rural Sanitary Authority.

It certainly seems that the criticism of the Spittle Brook supply was taken seriously by the Rural Sanitary Authority, for Pritchard gauged the stream again on 30th April, and was said to be ‘still firmly of the opinion that sufficient water will be found. In fact with storage, the brook flow is sufficient for a larger town.’ The result was reported by Langston Jones in a letter to the Marquess of Hertford, with the comment that ‘It will be seen that the objection to the quality in the Spittle Brook supply is really without foundation.’ [69]

By this time however, the Rural Sanitary Authority was also concerned with other matters of importance. On 9th May 1876, the Clerk was ordered to dispatch plans for the proposed Special Drainage District to the Local Government Board. This was intended to throw the financial burden of the sanitary improvement of Alcester town upon the ratepayers of that place rather then upon the parish of Alcester as a whole. The resolution to apply for this power was the work of the Marquess of Hertford, whose tenants had a good deal to gain from such a proposal.[70]

The Special Drainage District was intended to include almost the whole of Alcester Town, namely 482 houses, and an area of 192 acres with a rateable value of £4614, whereas outside the district and not therefore liable for a levy to support the schemes would have been 100 houses only, but 1508 acres and £3904 of rateable value, representing nearly half the parish's total of £7682.[71] Much of the land outside the intended district was in the ownership of Lord Hertford himself, and occupied by his tenant farmers.

Having received the plans and particulars of the proposed district, the Local Government Board soon responded, for the meeting of the Sanitary Authority on 13th June was informed by the Clerk of the Board's intention to hold a public inquiry in the town, with Samuel J. Smith, C.E. acting as inspector and chairman, on 21st June. The event was deemed important enough to warrant an editorial comment in *The Alcester Chronicle* of 17th June 1876.

The enquiry was held in the Town Hall, Alcester, with Langston Jones representing the Rural Sanitary Authority and the Reverend Mr Philpin the opposition.[72] Little new evidence was presented by either side, and the opposition was thrown rather into disarray when the inspector refused to allow discussion of the water scheme before the Special Drainage District had been considered. After some blustering, Mr Philpin refused to give evidence or answer questions on this subject and other witnesses were called. These were mostly opposed to the Special Drainage District on the grounds of unfairness to the town's ratepayers.

Technical matters came under discussion when in response to a question from Mr. Philpin, asking whether a sewerage system would be needed if a wholesome water supply were available, the inspector stated that ‘if the drains were bad they would have to do them. That was all.’ Philpin’s retort was that ‘that would wind them up completely.’

A move by the Philpin party to obtain an adjournment for ‘the purpose of getting scientific evidence to oppose the scheme’ got nowhere when it turned out that the alternative source proposed by those requesting the adjournment was the wells in the town already in use. Smith, the inspector, quoted from Ballard's report, describing the subsoil as ‘perfectly saturated with sewage matter, the whole of the water-bearing strata being contaminated.’ This, he thought, indicated that the wells would remain suspect even if leakage from the cesspits was prevented. Likewise he dismissed a suggestion that a perfect drainage system would remove the need for a new water supply.

The discussion took a more personal note when Mr. Walker gave evidence. He stated openly that the Special Drainage District was merely a device for throwing the whole financial burden on the town :

> They had a very large proprietor in the neighbourhood who proposed the special drain-

age district, and whose property to a very large extent would be exempt. That owner was the Marquess of Hertford, the Lord Chamberlain.

Walker proceeded to demonstrate his point with an analysis of the ratings of the parts of the parish within, and without, the proposed district, but his point was never answered, nor even discussed, for Langston Jones at this juncture asked a question about Walker's attitude to the earlier attempt to obtain a Local Board of Health, which acted as an effective diversion.[73]

After further peppery exchanges between Philpin and the inspector over the application for the adjournment, the application was overruled, at which point 'a number of ratepayers left the room. . . . . one or two of them making use of some very uncomplimentary remarks' as *The Alcester Chronicle* had it.

Pritchard was now examined on the water scheme, the inspector making no adverse comments and at one point stating that the water was hard but 'otherwise good according to the analysis'. Shortly after this the inquiry was closed.

Although the main purpose of the inquiry was to consider the Special Drainage District, it had the effect of discomforting the opposition to the Sanitary Authority's water scheme, and its leader, the Reverend Mr Philpin was at times made to appear foolish by the inspector's questions. While the water scheme proposed received no praise from the inspecting engineer, at least it incurred no criticism, which is more than could be said for the alternatives, suggested by the opposition party. On the other hand, the Rural Sanitary Authority could not have proceeded with the water scheme with confidence until the result of the inquiry was published, since should the plan for the Special Drainage District be rejected by the Local Government Board, the Marquess of Hertford could put many obstacles in the way of the Spittle Brook scheme as the only landowner involved, for he thus controlled the abstraction of water from the brook. The Special Drainage District was essential to the Spittle Brook scheme; upon it depended the goodwill of the Marquess of Hertford, and without that the Rural Sanitary Authority would have been in severe difficulties.

Pending receipt of the Local Government Board's decision, the Rural Sanitary Authority followed a policy of inactivity over the sanitary improvement schemes. The opposition, as well as writing critical letters to *The Alcester Chronicle*, formed a 'Water Committee' at the Court Leet in the Autumn.[74] In November, a possible alternative source of water had occurred to the opposition to the Pritchard scheme. This was the sinking of 'Abyssinian tube wells' (so named because the British Army had used them in its then recent campaign in Abyssinia). The proposal was to sink 200 of these deep wells, and purchase 200 pumps at £7 each. The outlay, at £1400 would have been about £2,000 less than that needed for Pritchard's water scheme.[75] Being much deeper than the existing sub-soil wells, the new borings would tap supplies free from contamination by seepage from cesspools or sewers, and unaffected by surface water.

Once the idea was proposed, enthusiasm for it grew rapidly, and an 'Abyssinian pump' was purchased by public subscription so that a test boring could be attempted.[76] Eventually artesian water was struck eighty feet below the surface with pressure sufficient to raise it 4 feet above ground level with a yield of 270 gallons per hour.[77] The Water Committee (whose scheme this

was) must have been greatly encouraged at the outcome, especially when Legrand & Sutcliff, the well sinkers, expressed the opinion that ‘tube wells can supply Alcester with its own water-works.’[78] But they also stated the terms on which they were prepared to allow the test well to remain: ‘at the nominal price of £30, £16 less than the average price for a bored tube-well eighty feet deep.’ This must have been unwelcome news to the tube-well enthusiasts for 200 tube-wells at £46 each would have greatly exceeded the cost even of Pritchard's scheme; nonetheless the Water Committee resolved to lay a plan along these lines before the Rural Sanitary Authority.[79]

This was in January 1877; by 13th February the Rural Sanitary Authority was occupied with other considerations, for the minutes of the meeting held on that day record that the Local Government Board had refused to allow the formation of the Special Drainage District. In fact the letter conveying the decision had been received by the Clerk, Langston Jones on 30th January and he had written at once to the Marquess with the news, which he described as 'a great injustice to the outlying part of the parish.' [80] Apparently the Local Government Board also limited the period for repayment of the proposed loan to thirty years instead of fifty which Langston Jones described as ‘a serious tax on the present generation of ratepayers.’ In the same letter he mentions ‘a project afoot to supply the town of Alcester with water from a large well, worked by a wheel into a water tower, and from there gravitated by pipes thro' the town.’ Langston Jones suggested that this would be ‘attended with half the expense of Pritchard's scheme, and further stated that a company would be formed to carry out this object as soon as a favourable analysis was received.[81]

In order for the company to have any chance of success of course, Pritchard's scheme had to be abandoned. Langston Jones therefore suggested to the Marquess that he should withhold his consent to the abstraction of water from the Spittle Brook, on the grounds that there was an understanding that the cost of the water scheme would be thrown upon Alcester town only; since the Local Government Board would not allow this, Langston Jones contended that Lord Hertford was justified in withdrawing his consent, thus leaving the way clear for the company to undertake the supply of water to the town.[82]

The Marquess lost no time in acting upon this suggestion and informed the Sanitary Authority that he withdrew his consent for the Spittle Brook scheme.[83] Possibly the Local Government Board had suspected something of this sort, for the letter that refused the Special Drainage District also contained an enquiry about the right of the Rural Sanitary Authority to take water from Spittle Brook. In fact the Pritchard scheme was unlikely to have been feasible in the face of opposition from the Marquess, even if he had not formally withdrawn his consent; from this point the Spittle Brook scheme was no longer a serious possibility.

By the 13th March the new scheme had undergone modification, apparently as a result of a proposal to use ‘hydraulic pressure.’[84] to raise the water to the storage tower, taking water for this purpose from Ragley Mill pound just to the north of the town. This proposal attracted comment from the Marquess's agent, Randell, who in a letter to Langston Jones, drew attention to various defects of the scheme, and proposed three alternatives of his own.[85] One of these was to take water from a spring in Oversley parish and lead it by means of an aqueduct under the Midland

Railway and Evesham Road to the old stone quarry at Arrow, and use the power of the Rock Mill Stream to drive a waterwheel.[86] This would operate pumps to lift the water up to an underground reservoir on Grunt Hill above, whence it would gravitate to the town. (See figure 2.3) This is in essence the scheme eventually operated by the Alcester Waterworks Company; it supplied the town with water for nearly seventy years, and Randell must be considered its author. From this point, events moved swiftly. Lord Hertford praised the Randell scheme at the Rural Sanitary Authority meeting on 10th April; Langston Jones again claimed that it would not be attended with half the expense of the Spittle Brook proposal. On 5th May *The Alcester Chronicle* announced a public meeting to be held at the Town Hall concerning 'a public scheme for providing water by means of a public company in order to prevent any charge on the poor rates will be submitted for approval and support.' The meeting, held on 7th May, opened with an outline of the events which had led up to the proposal to form a water supply company given by Langston Jones.[87] Then followed an engineer's report, dated 1st May 1877. The engineer, Millward [88] considered the possible power yield from the Rock Mill Stream as 2½ horsepower (1.9 kilowatts) and rejected this as inadequate for the pumping duty required, which he estimated at 7-8 horsepower (about 6 kilowatt). He further rejected the possibility of using an hydraulic ram, and maintained that steam power was the only solution to the pumping problem. His estimate of the necessary supply was 40-50 thousand gallons (182-227 $m^3$) per day, to be raised from the spring at Rock Mill [89] to the reservoir, in a working day of ten hours. The reservoir was to hold 90,000 gallons (409$m^3$) and would yield a head of fifty feet (15.24m) in the town. The estimate of the cost of all necessary works, including steam engine plant, was put at £1,450 (described as 'a tentative estimate in the absence of a detail plan'). Pumping costs were estimated at 3d (1.25p) per 1000 gallons (4.54 $m^3$) , and the engineer estimated that this would yield an adequate return on capital at the usual charges for the water.

This report was read by Langston Jones; he announced that the report had the approval of Mr. Randell, the agent of the Marquess of Hertford, and that the latter had indicated that his Lordship might take up shares in the proposed company. With regard to costs, Langston Jones considered that at least £2,000 would be needed, to be raised with 400 shares at £5 each, and compared this favourably with Pritchard's scheme at £3,035, which might well cost more in any case. Eventually the following resolution was proposed by the Rector of Alcester, the Reverend A. H. Williams, after he had remarked upon the careful attitude which the shareholders of the company would have to their own money, and how closely they would look at expenditure :

> that it is the unanimous feeling of this meeting that any permanent charge on the poor rates of Alcester especially for sanitary purposes should if possible be avoided; and therefore, in lieu of Mr. Pritchard's scheme for supplying the town of Alcester with water under the control of the Alcester Sanitary Authority , it is desirable to form a company for that purpose with nominal capital of £2000, divided into 400 shares of £5 each, and this meeting pledges itself to support the prospect by all possible means.

The motion's seconder added optimistic comments upon the prospective dividend for 'he had looked through a number of shares lists of water companies, and he could not find one but which

was paying a good dividend, from 10% and upwards. He considered that this would be a good investment for their capital (Applause)' Even the Reverend Mr Philpin supported the motion, which when put to the vote was unanimously carried, as was a further motion requesting the Rural Sanitary Authority to apply to the Local Government Board for permission to withdraw Pritchard's scheme and appointing a deputation to convey these decisions to the Sanitary Authority. *The Alcester Chronicle* noted that 'Applications for about 100 shares were made in the room, and more than half the capital has since been subscribed.'

The next meeting of the Sanitary Authority took place on the following day, the 6th May, and it was duly resolved to request the Local Government Board to grant permission to withdraw Pritchard's scheme, as suggested by the public meeting. Thus the Rural Sanitary Authority turned its back on the Spittle Brook plan, and committed the supply of wholesome water to the town to private enterprise. It was further resolved to ask the Local Government Board to reconsider its decision over the Special Drainage District; the reason for this is not apparent, since the water supply scheme was to be shelved, and the scavengering scheme was intended to cope with the sewage, so little or no public expenditure would have been involved. Despite the enthusiasm fur taking up the shares, Millward's proposals for the use of steam power were soon under criticism, and rightly so. For assuming that the daily demand was indeed 45,000 gallons (mid-way between Millward's suggested limits), pumping costs alone would amount to about £200 per year, and moves were soon afoot to ensure that steam power was not employed. This was done by asking the Marquess of Hertford to state that he would only take up shares in the proposed company on the understanding that steam power would not be used, and having this point explicitly stated in the agreement between him and the company which allowed water to be taken from his land.[90]

By the 12th June the steam pumping plan had been abandoned, for Langston Jones was able to write to the Marquess that 'there is now no difficulty in forming the company'.[91] Nonetheless, Millward's calculations had indicated the inadequacy of the Rock Mill Stream as a power source, so the anti-steam party had to suggest some reasonable alternative. The solution was to divert the waters of the Spittle Brook into the valley of the Rock Mill Stream, to augment the flow rate of the latter. This new modification of the scheme was announced to the Rural Sanitary Authority meeting on the 12th June by the Clerk, Langston Jones, who gave the impression that the objection to steam power had been raised by the Marquess himself (whereas in fact Langston Jones had himself raised the objection to the Marquess), and that the latter would take shares in the company if the 'perpetual cost' of steam power were avoided. 'There would be no annual working expenses and the company would. be a perfectly safe investment'.[92] There is no evidence to show who was responsible for the idea to divert the Spittle Brook into the Rock Mill Stream, Possibly it was Langston Jones himself, possibly Randell, the Marquess's agent. In any event the plan was eventually put into operation, and the combined streams provided pumping power via a large waterwheel for many years.

The shareholders of the new company held their first meeting in Alcester Town Hall on the 26th July 1877. Langston Jones had by now become the company's solicitor as well as the Clerk to the Rural Sanitary Authority, and he was able to report that 321 shares had been sub-

scribed for, and that promises suggested that the remainder would be. Seven directors were appointed, as well as the Company Secretary and the bankers to the Company.[93]

These matters having been decided the Company was registered on 28th July as the Alcester Waterworks Company Limited, its Memorandum of Association listing the seven directors with their holdings of shares. All were local businessmen or tradesmen; some were prominent opposers of the Rural Sanitary Authority's scheme.

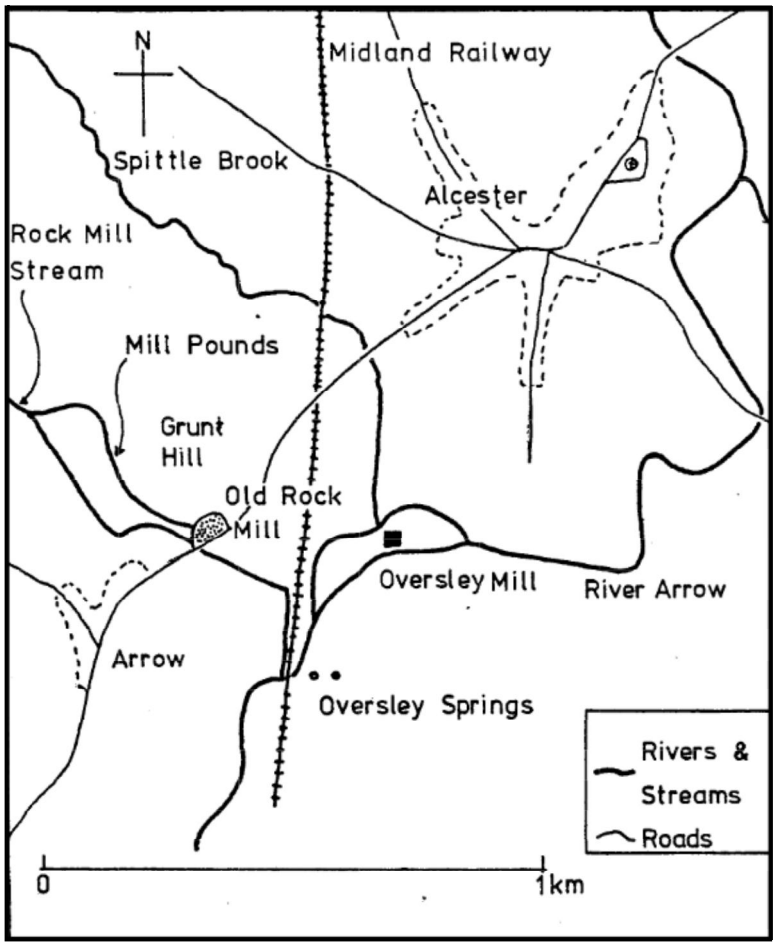


**Figure 2.3 Old Rock Mill and the Oversley springs**

On the 18th August the Sanitary Authority received permission from the Local Government Board to withdraw the Spittle Brook scheme provided that it was satisfied that the company would be able to supply the town with water. This removed the last legal obstacle from the Company's path. On 14th November the Reference Book setting out details of the proposed works was deposited with the Clerk of the Peace for Warwickshire and on 29th the engineer's detailed plans and sections followed.[94] Meanwhile test pumping had been going on at the Old Rock Mill at Arrow to determine the yield of the well there. This was found to be insufficient, and it was necessary to revert to the plan for bringing water from the spring in Oversley to the site of the pumping station.[95] This decision must have been made by 14th November, for the works needed are mentioned in the Reference book, and shown on the detailed plans.

On 1st of December The Alcester Chronicle reported that Langston Jones was able to tell a meeting of shareholders that Parliamentary plans and notices had duly been given, and that there was nothing to prevent the works being constructed in due course.[96] The Provisional Order authorising the Company to proceed with the works was obtained in 1878 and tender of £1,800 was accepted.[97] The contract was at once proceeded with and by February of 1879 the works were nearly complete, the laying of water mains and service pipes having been delayed by frost.[98]

On 11th March 1879 the Clerk of the Rural Sanitary Authority was able to report that the works of the Alcester Waterworks Company were complete and in a position to supply the town with 'pure and wholesome water'.[99] The waterworks were declared open without ceremony on the 25th March, the event passing without comment from *The Alcester Chronicle*. *The Stratford-upon-Avon Herald* did record it however, and described the test of the fire hydrants that was made on the 24th March when 'some experiments were made with hydrants and hoses on fire boxes and were found to answer most admirably.' The water was announced to be of excellent quality.[100]

## Notes and References to Chapter 2

1. The whole of the area concerned lies within Ordnance Survey grid squares SP 05 and SP 06.
2. Saville G. E. ; *Alcester Warwickshire: Census of 1861*; Alcester and District Local History Society, Occasional Paper No.6, March 1977. Copies of the Society's Occasional Papers are to be found at Warwickshire Record Office.
3. Ibid
4. *Kelly's Directory for Worcestershire, Warwickshire and Staffordshire,* 1884.
5. Johnson C.J. : *Stage Coach Routes through Alcester*; Alcester and District Local History Society , Occasional Paper No. 5, December 1976.
6. *Kelly's Directory for Worcestershire Warwickshire and Staffordshire, 1884*.
7. S*cience and Public Health; An Interfaculty Second Level Course Science and the Rise of Technology Since 1800*. Block unit 10; The Open University Press, Milton Keynes, 1973.
8. Frazer W.M. ; *A History of English Public Health 1834 - 1939*; Bailliere, Tindall and Cox; London 1950; page 110.
9. Op.Cit. (Note 7), page 42.
10. The parishes were :- Abbots Morton, Feckenham, Inkberrow and Oldberrow (in Worcestershire) and Alcester, Arrow, Great Alne, Aston Cantlow, Bidford, Coughton., Exha1l, Haselor, Ipsley, Kinwarton, Morton Bagot, Oversley, Salford, Sambourne, Spernall, Studley , Weethley and Wixford in Warwickshire. The population of the district in 1881 was 19,424, and the rateable value £100,445. Details from Kelly's Directory, Op. Cit. , 1884.
11. WRO,CR 51/92, 10th December 1872.
12. Listed in Kelly 's Directory for Warwickshire 1876 as 'George Haynes Fosbroke (junr), Medical Officer to the Rural Sanitary Authority' but no medical qualifications are mentioned. In The Alcester Chronicle 6th November 1875 he is referred to as 'G.H. Fosbroke (un) S.Sc.C. Cantab', while the Stratford-upon-Avon Herald of 5th November 1875 lists him among the successful candidates in 'State Medicine' at Cambridge and accredits him with MRCS. The paper states that anyone on the Medical Register and over 24 years of age may present himself for the examination, so Fosbroke must have possessed a registrable qualification before this.
13. In 1870 a Dr. Ballard, then Medical Officer of Health for Islington, published a classic study of the transmission of typhoid fever. Op.Cit note 7, page 50.
14. *The Alcester Chronicle* started publication in 1864, and is still in print at the present time. The only complete file of back numbers is to be found at the British Museum Newspaper Library, Colindale, London. An incomplete series from 1888 onwards is kept in the local history section of Redditch Library, Redditch, Worcestershire.

15. AC, 16th January 1875. Report of the meeting of the Alcester Rural Sanitary Authority.
16. AC, l3th February 1875.
17. WRO, CR51/92, 27th February 1875.
18. AC, 27th February 1875. Report of the Rural Sanitary Authority meeting. This gives far more detail than the minutes kept by the Clerk of the Rural Sanitary Authority, who omitted many of the uncomplimentary details.
19. An account of the development of theories of disease transmission is given by Frazer (Op. Cit. note 8), page 69. By this standard Ballard would appear to have been up to date in his knowledge of the subject.
20. Ballard 's reason for this statement is unknown, but he is known to have met Lord Hertford and Fosbroke on his visit. Possibly one of them made the suggestion. In any case the 'moderate cost' can only have been a guess.
21. PRO, MH12, 13224X/K5523. Ballard E. *Report of the Sanitary Condition of Alcester and upon an Epidemic of Small Pox in the town*, 20th March 1875.
22. PRO, MH 12, 13224,X/K5523. Fosbroke G. H. ; *Report to the Alcester Rural Sanitary Authority on the Sanitary condition of Alcester*, 15th September, 1874.
23. Sherwood Taylor, F. ; *The Century of Science*; Heinemann London, 3rd Edition, 1952; page 108.
24. Practitioners at this time did not always distinguish in diagnosis between pulmonary tuberculosis. and other infections of the lung such as bronchial pneumonia. Op. Cit. (note 7), page 53.
25. Sherwood Taylor, F. ; Op. Cit. , page 190.
26. It would seem that Fosbroke was still at the earliest stage described by Frazer (Op.Cit. , note 19) in that he appears to believe that atmospheric miasma alone can cause epidemic disease. There is evidence that he still held to miasmatic theories as late as 1889; see Report of Medical Officer of Health for Alcester Rural District, year ending 31st December 1889; ROW, BA 837, 250-2.
27. The Alcester wells were sunk into the gravel and sand which make up the drift deposits upon which the town is built. These contained water but were liable to contamination and pollution. (Richardson, L. ; *Wells and Springs of Warwickshire, Memoirs of the Geological Survey of Great Britain*, H.M.S.O. 1928.
28. Fosbroke described the privies in detail in his first report to the joint sanitary authorities:- ‘Excrement disposal is by privies emptying into underground middens and cesspools; by WC; and by tub or earth closet. Water closets are rare even in Stratford-upon-Avon.’ *Report of Medical Officer of Health for the Joint Districts of Stratford, Alcester and Evesham*, year ending 31st December 1874; ROW, BA 837, 250-2.
29. WRO, CR 51/92, 1st June 1875.
30. Pritchard, Edward; Architect, Surveyor and Civil Engineer is listed as residing at 21 Church Street, Warwick in *Steven's Directory of Coventry, Leamington, Kenilworth, Nuneaton and Warwick, 1880*. He was also Vice-President and Hon. Secretary of the Association of Municipal and Sanitary Engineers and Surveyors; (AC, 6 November, 1875).
31. WRO, CR 51/92; 29th June 1875.
32. Ibid; 27th July 1875.
33. Ibid; 2nd. November 1875.
34. AC, 6th November 1875. The account of Pritchard's schemes is based entirely on the newspaper report. The minutes of the Rural Sanitary Authority give us no details at all.
35. The modern water analyst uses the presence of the organism Escherichia coli as the crucial criterion of sewage pollution of a water supply. This organism is not itself pathogenic, but abounds in the human gut, so that its presence in a water sample indicates contamination by sewage. This test was not available in the late 1870's, for microbiology was scarcely even in its infancy. The chloride test was commonly used at this time. Human urine contains a considerable amount of sodium chloride, so that a high concentration of chloride ion in a water sample suggests contamination with sewage. The use of this test by the Medical Officer of Health on water from a well suspected of being polluted was described in The Alcester Chronicle for 24th June 1876. Both the analyses quoted by Pritchard indicated that the Spittle Brook water would be regarded as an acceptable source of water by modern standards; see page 102, *Clean and Dirty Water: Water Analysis, Standards and Treatment, Environmental Control and Public Health, Units 5-6*, Open University Press, Milton Keynes, 1975.

36. Francis Seymour, 5th Marquess of Hertford,1812-1884. Succeeded to the title 1870. His predecessor lived entirely in Paris and neglected the Ragley Estate, which forms a large part of Alcester parish. The 5th Marquess lived at Ragley Hall and attempted to put the estate in order. He was Equerry to the Prince Consort, and later Lord Chamberlain to Queen Victoria. 8th Marquess of Hertford; *Ragley Hall*; English Life Publications, Derby 1975.

37. This amounts to about 13 gallons per head per day. For the Warwick scheme Pritchard allowed 25 gallons per head per day but Warwick had a relatively large number of water closets. Pritchard E; *Report on Proposed Water Supply from Haseley* (prepared for the Borough of Warwick; George Lacy, Warwick, 1873. A copy of this pamphlet is to be found under WRO, CR114a/736/l.

38. Pritchard was the engineer for the Warwick water supply scheme, and delivered a paper about it to the meeting of the Midland District Committee of the Association of Municipal and Sanitary Engineers and Surveyors, on 19th April 1876. Th paper was published under:- Pritchard E. ; *Warwick Water Supply*; Henry Cooke, Warwick 1876. A copy is to be found under WRO, CR 114a/736 1.

39. Pritchard had designed the sewers to allow for a flow rate of 2 feet per second ($0.601ms^{-1)}$when half full in 'nearly every instance' (AC /6 November 1875.)

    In designing London's sewerage scheme, Bazalgette had allowed for an average speed of 1½ miles per hour ($0.671ms^{-1}$ ) Derry, T.K. and Williams, T.I.; *A Short History of Technology from Earliest Times to A.D. 1900*; Oxford University Press, London, 1960).

    Modern practice suggests that a flow rate between 0.6 and 0. $75ms^{-1}$ should be aimed for. (*Water; Distribution, Drainage and Disposal, Administrative Control, Environmental Control and and Public Health, Units 7-8* :Open University Press, Milton Keynes, 1975 )

40. The purification of sewage requires bacterial oxidation of the organic matter present to simple ions and molecules. Usually this is carried out in a specially designed filter plant. Towns have been known to dispose of the sewage by distributing it on the surface of land reserved for the purpose; the oxidation took place on the soil surface. Salisbury followed this practice in the 19th century (*Derry and Williams; Op. Cit.*, note 39). Pritchard was proposing to distribute the effluent *beneath* the surface of the soil.

41. Pumping would have had the advantage of allowing a better control of gradients in the sewers, since these would have drained into a sump at any convenient depth, from which the pump could have lifted the effluent to the level of the treatment plant.

42. Pritchard must here be referring to untreated sewage. The Rivers (Prevention of Pollution) Act, 1878 was under discussion in Parliament as a bill at this time. It prohibited the discharge of untreated sewage into rivers. Pritchard was suggesting that under flood conditions small amounts of raw sewage would not seriously pollute the augmented volume of the river

43. WRO, CR51/92; 24 August 1875.

44. WRO, CR 114a/736/2. Letter from Mr. Menzies to the Marquess of Hertford, 16 November 1875.

45. It is not easy to see why Pritchard adopted this unusual method of disposal unless it was because discharge at a higher level would have resulted in unfavourable (i.e. shallower) gradients in the sewers.

46. WRO, CR 114a/ 736/2; letter from Mr. Randell to Lord Hertford, 21 November 1875.

47. Alcester still retains its manorial court, the Court Leet, and the High and Low Bailiff. Its functions are purely decorative, but it does (and did) function sometimes as a vehicle for airing opinions on matters of public importance.

48. John Langston Jones, Solicitor, Clerk to the Magistrates, Registrar of the County Court, Clerk to the Union, Clerk to the Highway Board, Superintendent Registrar. (Needle District Directory 1878) . Later he was solicitor to the Alcester Waterworks Company Limited.

49. This suggests that considerable opposition to the schemes and their cost was already evident in the town.

50. The 'doubt about the feasibility of Mr. Pritchard's plans probably reflects the comments made by Randell and Menzies (see notes 44 and 46 above).

51. The Reverend Moses Philpin, Chairman of the Alcester Gas Light and Coke Company , Baptist Minister, and substantial property owner in the town.

52. This seems unlikely. The Local Government Board could compel the Rural Sanitary Authority to take action by legal process through the Court of Queen's Bench (see note 8 above), but would have been unlikely to act directly in the matter.

53. This could only have been a guess on Philpin's part, but not an unreasonable one. In the nineteenth centu-

ry engineers' estimates frequently turned out to be too low.

54. Pritchard obviously meant percolation from the existing drains, not the new sewers which he was proposing to install.

55. The Chairman (and High Bailiff) was Mr. T. Smith, of Smith and Son, surgeons, who practiced in the town.

56. The Chairman was correct. Foul drains. do not of themselves cause infection and as long as the water supply was not contaminated an outbreak of typhoid was unlikely.

57. In fact the Marquess's agent (Randell) had already drafted terms for the lease of land for the sewage disposal. WRO CR 114a/ 756/ 2; letter from Randell to Lord Hertford, 19th November 1875.

58. The Inspector of Nuisances gave evidence at a public enquiry to the effect that water from polluted wells was often free from objectionable smell, appearance and taste. AC /24 June 1876.

59. Property owners had a powerful incentive to oppose the water scheme since they would have had to bear the cost of installing a piped supply in their property. Ratepayers likewise feared an increase in rates. These considerations no doubt encouraged scepticism over the scientific evidence.

60. The Rural Sanitary Authority had the water from Walker's well analysed at the same time as a repeat sample from the Spittle Brook in May 1876. The water from Walker's well was found to be slightly harder than that from Spittle Brook. WRO; CR 114a/736/1. Letter from Langston Jones to the Marquess of Hertford. 11 May 1876.

61. AC 22 January 1876. Statement of Langston Jones to the meeting of the Rural Sanitary Authority held on 18 January 1876.

62. AC 22 January 1876. The newspaper gives full details of the proceedings which took place. These do not appear in the minutes of the meeting.

63. WRO, CR51 92; 30 November 1875.

64. Ibid 18 January 1876.

65. AC, 4 and 11 December 1875 and 5 February 1876.

66. WRO, CR51/92; 14 March 1876. 7. AC, 18 March 1876, page 1, an advertisement 'Noticing the construction in "The Chicken Meadow" (Alcester Lodge Farm) in the occupation of - Mrs Martha Bomford, of a reservoir to hold 600,000 gallons of water with necessary leaping weir, tanks, filter beds, service mains and pipes for the purpose of providing the town of Alcester with water.' (see figure 2.2)

68. AC, 15 April 1876.

69. WRO, CR 114a/736/1. See note 60 above.

70. Op. Cit., note 43 above.

71. AC, 24 June 1876. Report of Public Enquiry held by the Local Government Board into the Special Drainage District.

72. This account is based on the detailed report in The Alcester Chronicle, AC, 24 June 1876.

73. The question asked by Langston Jones had no bearing on the point which Walker had raised, but had the effect of diverting the attention of the meeting away from it. Possibly Jones was attempting to shield the Marquess from public criticism.

74. AC, 21, 28 October 1876.

75. AC, 18 November 1876.

76. AC, 16 and 23 December 1876 and 6 January, 1877.

77. It is not clear why the water should have been under artesian pressure since the Keuper Marl in which the water was located is almost horizontal under the town. The explanation may lie in the faulting of the Keuper series in the vicinity of Alcester. See Appendix A for a detailed description of the geology of the area.

78. AC, 13 May 1877. Page 1 carried an advertisement for ‘Norton's Patent Abyssinian Tube Wells' by Legrand and Sutcliff, Artesian Well Engineers, Magdala Works, 100 Bunhill Row, London.

79. AC, 13 January 1877, Report of meeting of the Court Leet.

80. WRO, CR/114a/736/2. Letter from Langston Jones to the Marquess of Hertford.

81. This could only have been an optimistic guess on Langston Jones's part. In the event the Company's

scheme cost nearly as much as Pritchard's would have done.

82. The minutes of the Rural Sanitary Authority record no such conditions imposed by the Marquess of Hertford. It seems to have been a pretext devised by Langston Jones himself. WRO, CR51/92; 18 January 1876.

83. WRO, CR51/92; 13 February 1877.

84. This probably refers to an hydraulic ram pump of the kind still manufactured by Blakes of Accrington, Limited. In his introductory remarks to the meeting held to discuss the Company's scheme on 12 May, Langston Jones referred to 'a ram to be worked by the river'. AC, 12 May 1877.

85. WRO, CR 114a/736/1; letter from Randell to Langston Jones, 17 March 1877.

86. Water power had been exploited on the Rock Mill site earlier in the nineteenth century. In 1804 the Marquess of Hertford had obtained an estimate for the construction of a needle mill on the site (although it is not known whether it was ever built). See WRO, CR 114a/89. The Arrow Tithe Map of 1847 clearly shows a leat leading from the Rock Mill Stream to the point where the pumping station was eventually constructed. This leat is labelled ‘canal’, and possibly is a vestige of the needle mill.

87. AC, 12 May 1877. The newspaper gives a full report of the proceedings.

88. John Millward, C.E., 27 Paradise Street, Birmingham (AC 12 May 1877). John Millward, 13 Lincoln's Inn, Corporation Street, Birmingham, is listed under Civil Engineers in Kelly's Directory' for Worcestershire, Warwickshire and Staffordshire, 1884.

89. This represents a change from Randell's original proposal (note 86). Presumably a well already existed on the Rock Mill site.

90. WRO, CR 114a/736/1; letter from Langston Jones to the Marquess of Hertford, 9 June 1877.

91. Ibid 12 June 1877.

92. AC 16 June 1877; none of the details given appear in the minutes of the Alcester Rural Sanitary Authority.

93. AC, 28 July 1877.

94. WRO, CR 1481/21; Reference Book for the Alcester Water Scheme. An ‘Application to the Board of Trade for Provisional Order to construct maintain and continue Waterworks and Works connected therewith in and to supply Water to the Parishes of Alcester and Arrow, and Hamlet of Oversley, all in the County of Warwick, and to levy rates, and for other purposes.’ The plan and sections may be found in Warwickshire Record Office, WRO. QS/III/350. Full details of the intended works are given in Appendix B.

95. AC, 17 November 1877. Report of meeting of Alcester Rural Sanitary Authority.

96. AC, 1 December 1877

97. Alcester Water Order 1878; 41, 42 Vict. Sess. 1878.

98. WRO, CR 114a/736/1; letter to shareholders of the Alcester Waterworks Company Limited, from Henry Overbury, Chairman of the Company, 17 February 1879

99. WRO, CH 51/92, 11 March, 1879.

100. Stratford-upon-Avon Herald, 28 March 1879. Bound copies of this newspaper are to be found in the Shakespeare Birthplace Trust Archive , Stratford-upon-Avon.

## Chapter 3 : Financial Development and Its Relationship To Pumping Costs

A water supply company is in many ways a curious commercial undertaking, for its assets – boreholes, wells, catchment areas and the like have for the most part little or no market value, while its revenue, if derived from water rents, tends to respond inflexibly to variations in demand. Indeed excessive demand may be an embarrassment for such a concern, since supply may be difficult or impossible to increase. Once the company has a consumer's property connected to its service mains, it has little or no commercial interest in its supply of water, and it was for this reason that the early sanitarians preferred schemes operated by the Sanitary or some other local authority to those organised by private undertakers, as in the case of Alcester.

The chief concern of the directors of a company supplying water would be for the return on the capital invested, that is the trading surplus, and the company would be judged as successful or otherwise by its financial performance. The directors would therefore strive to minimize both the capital invested and the working expenses, while maximising the revenue from water rents. The latter could be achieved either by connecting as many consumers as possible, or by making the water rents as high as possible, or both. The Alcester Waterworks Company had made connections to almost all the potential consumers in Alcester by 1884[1] and tended, at least until the 1920's, to increase water rents rather slowly, so its main scope for increasing profits lay in reducing the working expenses of the concern.

With respect to capital growth, it must have soon become evident that the authorised capital of the company (£2,000 in 400 shares of £5) was inadequate, even had all the shares been taken up[2], for as early as February 1879[3] when the works were still incomplete, the proposal had been made to raise a further £1,000 of capital. This was partly achieved in April of the same year when £5 preference shares were issued, paying 5% interest, to a value of £825; this enabled the Company to pay off the engineer and contractor. Outstanding liabilities, resulting from the legal expenses incurred in floating the concern remained however, and in 1881 a further proposal[4] for capital increase by issue of preference shares was made. By 1882 the total preference share capital had increased to £1,415, out of a total of £3,227 and it was further resolved in that year to increase this to £1,800. The annual report to shareholders in 1883[5] disclosed that only £100 had been raised by this way, but this brought the total capital to £3,327, of which almost 50% was in the form of preference shares, whose holders would take precedence over the ordinary shareholders should there ever be any trading surplus to distribute.[6] To the relief of these equity shareholders no doubt, the Company declared its first dividend (4%) in 1883.

Nonetheless the process of capital increase continued, reaching £3,600 in 1886 and £3,900 by 1896, nearly double the original authorised capital. Of this, £2,100 (about 54%) was held in 420 preference shares at £5 each and the remainder was held as 360 ordinary shares at a similar nominal value. The capital structure of the Company now remained unaltered for many years until, in connection with the Kinwarton scheme in 1940, the total capital was raised to £4,200, with 440 preference and 400 ordinary shares, and so it remained until the Company was wound up in 1947.[8]

The ability of the Company to raise a further £300 of capital in this way suggests that it was thought to be a worthwhile investment by those with capital to spare in the late 1930's. This had not always been the case. In 1880 for example, the Directors had reported 'difficulties' but 'looked forward to the Company's prosperity.' Although the first dividend on ordinary shares was declared in 1883, as mentioned above, the Directors themselves benefitted rather belatedly, for as late as 1885 the Company was still unable to pay them a salary,[9] and not until 1886 was the Chairman able to congratulate the Directors in his annual report for 'bringing the Company to a profitable state.' These congratulations were a little premature, as we shall see.[10]

If turning points have a real existence in human affairs and are not merely an effect of hindsight, it is possible to locate such a point in the affairs of the Alcester Waterworks Company, and it must be set in 1903. Before this time the Company could be said to have been struggling for its existence; afterwards it was financially secure, paying dividends on ordinary shares which reached a maximum of 10.5% for a brief period. Certainly the annual reports of the Chairman of the Company support this view. In 1905 for example, the Company was described as 'taking a turn for the better' and said to be 'now a paying concern'. A dividend of 4% (the highest for some years) was declared and the values of the shares was said to have risen. In 1905 a dividend of 5% on ordinary shares was declared and the Chairman maintained that the Company instead of being moribund was doing good work for the town.'[12] By 1913 the ordinary share dividend reached 7%, the highest which had ever been declared since the foundation of the Company, and the Chairman gave a brief account of the financial history of the concern. He reported that ordinary shareholders had received no dividend at all for a number of years and that even payment on preference shares had sometimes been suspended. The position in 1913 had been attained chiefly by reduction of working expenses and not by increased charges to consumers.'[13]

The evidence from the annual reports to shareholders then, suggests that 1903 might be regarded as the turning point of the Company's fortunes. In order to examine this claim it is necessary to consider the financial records of the concern with regard to variation in profitability as measured by some suitable index. Three indices of profit creation are worthy of consideration, namely the dividends paid on ordinary shares, the trading surplus as a proportion of the Company's assets and the trading surplus as a percentage of revenue.

The dividend paid on ordinary shares is a convenient measure but somewhat unreliable as a year by year index of financial success, since the directors could distribute as much or as little of the profit as they saw fit. Nevertheless, pressure from shareholders would be likely to encourage profit distribution if at all possible, so we may have some confidence that the figures show the changes in profitability in a long run. The record of ordinary share dividends for the Alcester Waterworks Company is presented in table 3.1 and displayed graphically in figure 3.1.[14]

Inspection of the data will show that dividends paid before 1904 tended to be lower than those paid afterwards, averaging 2.39% from 1880 to 1903 and 6.11% from 1904 to 1947. Whereas no dividend was paid on ordinary shares on seven occasions before 1904, this happened only twice between 1904 and 1947, when the Company was wound up. Although the Company paid a

dividend of no less than 10% for the last six years of its existence, it must be appreciated that this was partly a consequence of the inflation of money values which raised the surplus in nominal terms whereas the capital had been invested in the values of the late nineteenth century. The dividend was consequently bound to rise when expressed as a percentage of the share capital, and in real terms must have been less impressive.[15]

**Table 3.1: Ordinary Share Dividends 1880-1947** (From newspaper reports and the Company's Ledgers)

| Year | Dividend % | Year | Dividend% | Year | Dividend% |
|---|---|---|---|---|---|
| 1880 | 0 | 1903 | 3 | 1926 | 10 |
| 1881 | 0 | 1904 | 4 | 1927 | 2.5 |
| 1882 | 4 | 1905 | 5 | 1928 | 0 |
| 1883 | 5 | 1906 | 5 | 1929 | 2.5 |
| 1884 | 5 | 1907 | 5 | 1930 | 2.5 |
| 1885 | 5 | 1908 | 5 | 1931 | 5 |
| 1886 | 5 | 1909 | 6 | 1932 | 5 |
| 1887 | 2 | 1910 | 6 | 1933 | 5 |
| 1888 | 2.5 | 1911 | 6 | 1934 | 5 |
| 1889 | 3 | 1912 | 7 | 1935 | 6 |
| 1890 | 2.5 | 1913 | 7 | 1936 | 6 |
| 1891 | 0 | 1914 | 6 | 1937 | 6 |
| 1892 | 4 | 1915 | 6 | 1938 | 6 |
| 1893 | 2.5 | 1916 | 6 | 1939 | 6 |
| 1894 | 2 | 1917 | 6 | 1940 | 6 |
| 1895 | 0 | 1918 | 0 | 1941 | 7.5 |
| 1896 | 2.5 | 1919 | 2.5 | 1942 | 10 |
| 1897 | 2.5 | 1920 | 2.5 | 1943 | 10 |
| 1898 | 0 | 1921 | 2.5 | 1944 | 10 |
| 1899 | 5 | 1922 | 10 | 1945 | 10 |
| 1900 | 2 | 1923 | 2.5 | 1946 | 10 |
| 1901 | 0 | 1924 | 10 | 1947 | 10 |
| 1902 | 0 | 1925 | 10 | | |

An alternative view of profitability is obtained by considering the year by year trading surplus as a percentage of the book value of the Company's assets. The latter is likely to give a measure of the working capital of the concern in current terms, and thus a better indication of profitability in real terms. Table 3.2 shows the Company's assets from 1896 to 1947, together with the

trading profit, and the latter is expressed as a percentage of the former.[16] Before 1904 the yield on assets works out at 3.43% on average and the corresponding figure for subsequent years is 6.09%.

A third possible index of profit creation is trading surplus, expressed as a percentage of the revenue. Table 3.3 shows values for the revenue of the company together with the working expenses and the profit, and the profit expressed as a percentage of revenue.[17]

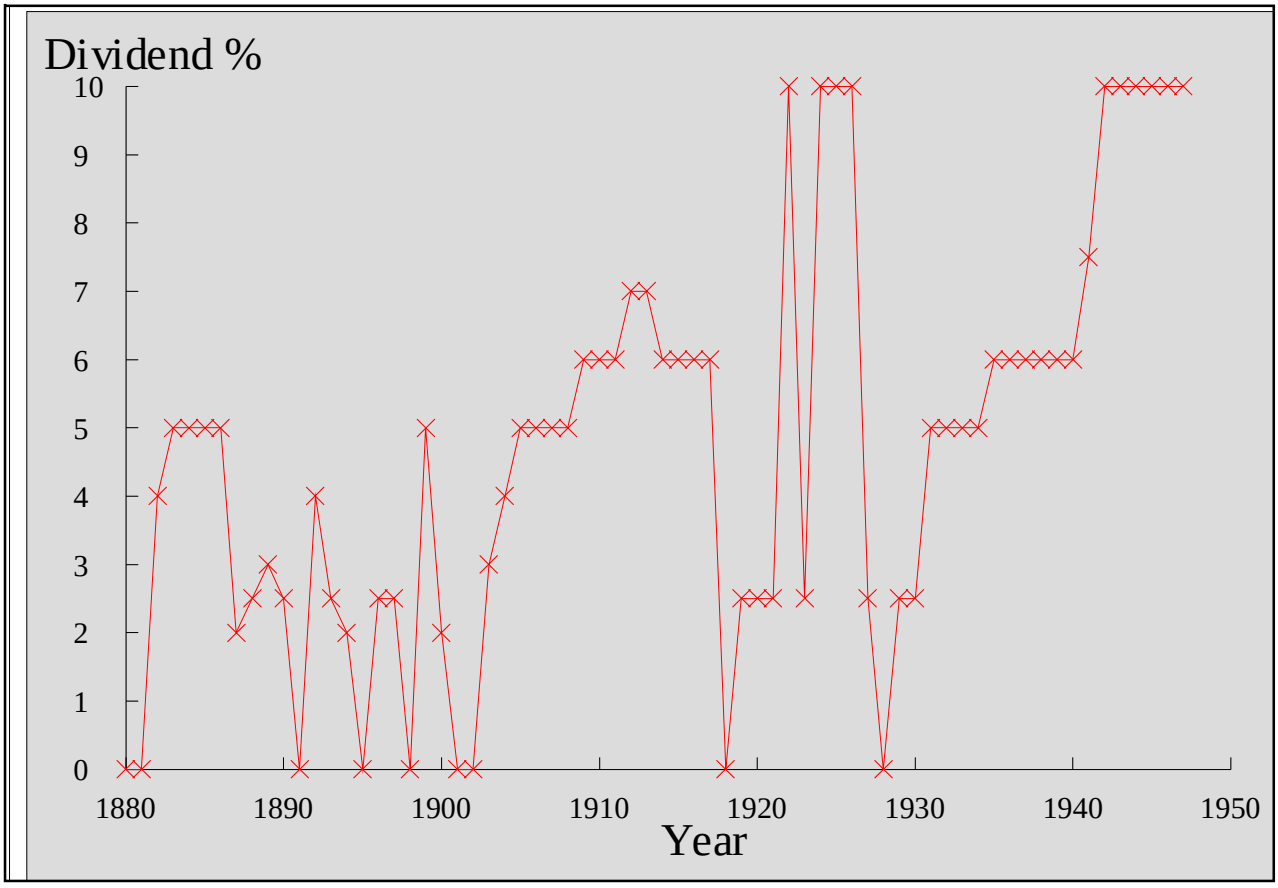


**Figure 3.1: Dividends Paid on Ordinary Shares, 1880-1948**

**Table 3.2: Assets, Profit and Yield on Assets. 1896-1947** (From the Company's Ledgers)

| Year | Asset Value (£) | Profit (£) | Yield % | Year | Asset Value (£) | Profit (£) | Yield % |
|---|---|---|---|---|---|---|---|
| 1896 | 4028 | 176 | 4.37 | 1922 | 4696 | 268 | 5.71 |
| 1897 | 4027 | 149 | 3.7 | 1923 | 4711 | 300 | 6.37 |
| 1898 | 4038 | 161 | 3.96 | 1924 | 4811 | 320 | 6·65 |
| 1899 | 4047 | 166 | 4·1 | 1925 | 5037 | 447 | 8·87 |
| 1900 | 4001 | 128 | 3·2 | 1926 | 5141 | 332 | 6·46 |
| 1901 | 3907 | 42 | 1·07 | 1927 | 5195 | 282 | 5·43 |
| 1902 | 3956 | 102 | 2·58 | 1928 | - | - | - |
| 1903 | 4034 | 181 | 4·49 | 1929 | - | - | - |

| Year | Asset Value (£) | Profit (£) | Yield % | Year | Asset Value (£) | Profit (£) | Yield % |
|---|---|---|---|---|---|---|---|
| 1904 | 4142 | 262 | 6·33 | 1930 | 4999 | 217 | 4·34 |
| 1905 | 4213 | 242 | 5·74 | 1931 | 5037 | 431 | 8·36 |
| 1906 | 4264 | 240 | 5.63 | 1932 | 5078 | 347 | 6·83 |
| 1907 | 4300 | 233 | 5·42 | 1933 | 5482 | 391 | 7·13 |
| 1908 | 4334 | 223 | 5·15 | 1934 | 5503 | 385 | 7·60 |
| 1909 | 4340 | 204 | 4·70 | 1935 | 5672 | 563 | 9·93 |
| 1910 | 4402 | 261 | 5·93 | 1936 | 5894 | 506 | 8·59 |
| 1911 | 4433 | 238 | 5·38 | 1937 | - | - | - |
| 1912 | 4483 | 257 | 5·93 | 1938 | - | - | - |
| 1913 | 4473 | 214 | 4·78 | 1939 | - | - | - |
| 1914 | 4465 | 218 | 4.88 | 1940 | - | - | - |
| 1915 | 4335 | 211 | 4·87 | 1941 | - | - | - |
| 1916 | 4366 | 211 | 4·83 | 1942 | - | - | - |
| 1917 | 4319 | 113 | 2·62 | 1943 | 7559 | 634 | 8·39 |
| 1918 | 4325 | 60 | 1·39 | 1944 | 7726 | 647 | 8·37 |
| 1919 | 4372 | 161 | 3·68 | 1945 | 7897 | 694 | 8·79 |
| 1920 | 4345 | 139 | 3·20 | 1946 | 8069 | 683 | 8·46 |
| 1921 | 4641 | 223 | 4·8 | 1947 | 8225 | 658 | 8.00 |

Figure 3.2 shows the variation in percentage profit expressed in this way, and the period from 1904 to 1916 stands out as a time of great prosperity for the concern, when the profit was consistently close to or greater than 50% of revenue. This success was never to be repeated; profit only exceeded 50% of revenue on one occasion after 1916. This was in 1935, and thereafter the profit was consistently below 45% of revenue until the Company was wound up.

**Table 3.3: Revenue, Working Expenses and Profits 1896-1947**

(Based on the Company's Ledgers)

| Year | Rev. (£) | Exp. (£) | Profit (£) | Profit % | Year | Rev. (£) | Profit | Exp. (£) | Profit % |
|---|---|---|---|---|---|---|---|---|---|
| 1896 | 357 | 184 | 176 | 49.3 | 1922 | 823 | 555 | 269 | 32.7 |
| 1897 | 350 | 200 | 149 | 42.3 | 1923 | 797 | 497 | 300 | 37.6 |
| 1898 | 352 | 192 | 161 | 45.6 | 1924 | 804 | 484 | 320 | 39.8 |
| 1899 | 347 | 181 | 166 | 47.8 | 1925 | 1004 | 557 | 447 | 44.5 |
| 1900 | 344 | 216 | 128 | 37.3 | 1926 | 882 | 551 | 332 | 37.6 |
| 1901 | 350 | 308 | 42 | 12.2 | 1927 | 899 | 618 | 282 | 31.3 |
| 1902 | 352 | 250 | 102 | 28.9 | 1928 | - | - | - | - |

| Year | Rev. (£) | Exp. (£) | Profit (£) | Profit % | Year | Rev. (£) | Profit | Exp. (£) | Profit % |
|---|---|---|---|---|---|---|---|---|---|
| 1903 | 378 | 197 | 181 | 47.8 | 1929 | - | - | - | - |
| 1904 | 405 | 143 | 262 | 64.8 | 1930 | 843 | 627 | 217 | 25.7 |
| 1905 | 405 | 163 | 242 | 59.8 | 1931 | 892 | 461 | 431 | 48.3 |
| 1906 | 401 | 161 | 240 | 59,9 | 1932 | 880 | 534 | 347 | 39.4 |
| 1907 | 414 | 180 | 234 | 56.4 | 1933 | 956 | 565 | 391 | 40.8 |
| 1908 | 414 | 191 | 223 | 53.9 | 1934 | 995 | 610 | 385 | 38.7 |
| 1909 | 403 | 199 | 204 | 50.5 | 1935 | 1078 | 515 | 563 | 52.2 |
| 1910 | 424 | 163 | 261 | 61.5 | 1936 | 1076 | 570 | 506 | 47.O |
| 1911 | 426 | 188 | 238 | 55.9 | 1937 | - | - | - | - |
| 1912 | 419 | 162 | 257 | 61.4 | 1938 | - | - | - | - |
| 1913 | 422 | 207 | 214 | 50.8 | 1939 | - | - | - | - |
| 1914 | 421 | 203 | 217 | 51.7 | 1940 | - | | | |
| 1915 | 426 | 215 | 211 | 49.6 | 1941 | - | | | |
| 1916 | 422 | 211 | 211 | 49.9 | 1942 | - | | | |
| 1917 | 428 | 314 | 113 | 26.5 | 1943 | 1470 | 836 | 634 | 43.1 |
| 1918 | 448 | 387 | 60 | 13.4 | 1944 | 1543 | 896 | 647 | 41.9 |
| 1919 | 532 | 371 | 161 | 30.3 | 1945 | 1573 | 879 | 694 | 44.1 |
| 1920 | 543 | 403 | 139 | 25.7 | 1946 | 1579 | 895 | 683 | 43.3 |
| 1921 | 705 | 482 | 223 | 31.6 | 1947 | 1680 | 1022 | 658 | 39.2 |

Figure 3.3 shows the variation in revenue, working expenses and profit from 1896 until 1927, and it is clear that the period after say 1918 must be distinguished from the preceding years, for after this time the revenue of the Company rose very rapidly indeed, and tended to be the main determinant of profit. Before 1918 on the other hand revenue was relatively static, and profit seems to have been determined by the working expenses. Once again the period 1904 to 1916 stands out as a period of consistent profitability.

The considerations above suggest however that it might be more reasonable to restrict our comparison to the eight years before December 1903 and the eight years afterwards, when revenue was relatively stable and inflation had little or no effect upon the Company's finances. If this approach is adopted the importance of 1903 as a turning point is more apparent. Table 3.4 below summarises the information for all three measures of profitability.

Judged in this way it seems clear that from the viewpoint of an observer of the Company's affairs in 1913, 1903 did represent the clear turning point which the annual reports to shareholders would suggest.

It is also clear that this improvement in the financial position of the Company can be attributed to a fall in the working expenses, since the revenue varied very little over the whole period

of 16 years. Table 3.5 below demonstrates the point.


**Figure 3.2 : Profit as a Percentage of Revenue, 1896-1947**

**Table 3.4: Measures of Profitability, 1896-1911**

| | Period | |
|---|---|---|
| | 1896-1903 | 1904-1911 |
| Average yield on assets | 3.43 | 5.52 |
| Average profit as a % of revenue | 38.90% | 57.80% |
| Average dividend on ordinary shares | 1.56% | |

**From the Company's Ledgers**

Thus in the eight years after 31st December 1903, the working expenses of the Company formed a substantially smaller proportion of a slightly larger revenue, the latter having increased by only 4%, whereas the former had fallen by 20%. Likewise, average expenditure as a percentage of revenue fell from 61% to 47.4% from the first eight year period to the second. Indeed, given the almost static nature of the Company's revenue over this period, a reduction in working expenses was the only way of improving the financial status of the concern..

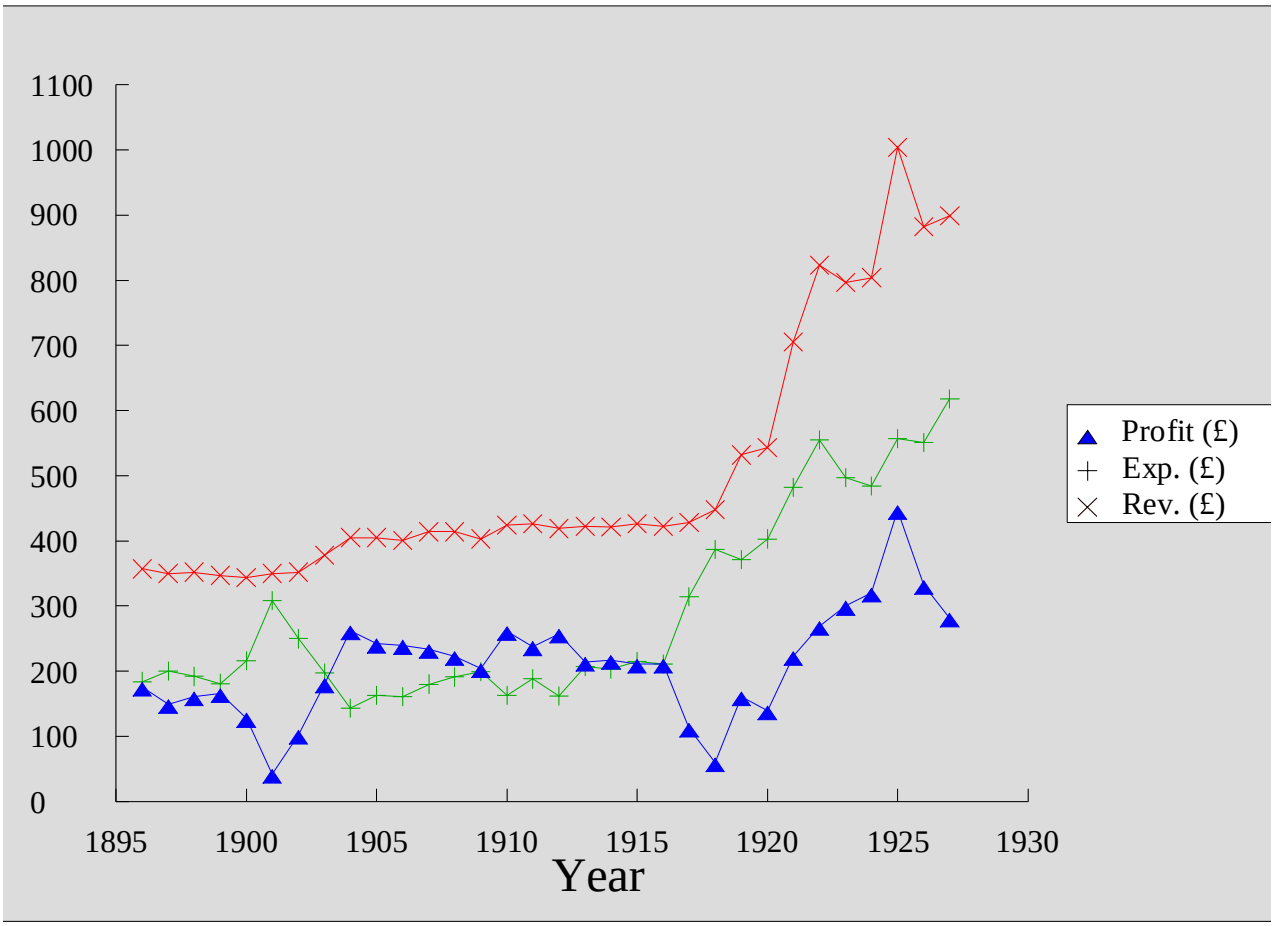


**Figure 3.3: Profit, expenditure and revenue, 1896-1927**

**Table 3.5: Revenue and Expenditure, 1896-1911** (From the Company's Ledgers)

| | Period | | |
|---|---|---|---|
| | **1896-1903** | **1904-1911** | **% Change** |
| Average revenue (£) | 353.67 | 366 | +4 |
| Average expenditure (£) | 215.88 | 173.48 | -20 |
| Average expenditure as a % of revenue | 61% | 47.4% | |

There is evidence that the fall in the total working expenditure was associated with a sharp drop in the expenditure on water pumping. Table 3.6 below presents data in support of this contention.

The figures show that in the period after 1904 the average sum spent annually on water pumping fell both in absolute and relative terms as compared with the period before 1904 and it seems reasonable to suggest that the fall in pumping expenses was an important factor in the fall in

total working expenses.

**Table 3.6: Pumping and Working Expenses, 1896-1911** (From the Company's ledgers)

| | Period | |
|---|---|---|
| | **1896-1903** | **1904-1911** |
| Average working expenses (£) | 215.88 | 173.48 |
| Average pumping expenses (£) | 87.01 | 55.17 |
| Pumping expenses as a percentage of total | 40% | 31.8% |

Table 3.7 shows sums spent annually on water pumping with total working expenses for the period 1896 to 1947, and the pumping expenses shown as a percentage of total expenses.

**Table 3.7: Working Expenses and Pumping Expenses, 1896-1947** (From the Company's ledgers)

| **Year** | **Working expenses (£)** | **Pumping expenses (£)** | **%** | **Year** | **Working expenses (£)** | **Pumping expenses (£)** | **%** |
|---|---|---|---|---|---|---|---|
| 1896 | 184 | 75 | 41 | 1922 | 553 | 146 | 26 |
| 1897 | 200 | 102 | 51 | 1923 | 497 | 86 | 17 |
| 1898 | 192 | 83 | 51 | 1924 | 484 | 67 | 14 |
| 1899 | 181 | 80 | 44 | 1925 | 557 | 120 | 22 |
| 1900 | 216 | 106 | 49 | 1926 | 551 | 146 | 27 |
| 1901 | 308 | 95 | 51 | 1927 | 618 | 113 | 18 |
| 1902 | 250 | 120 | 48 | 1928 | - | - | - |
| 1903 | 197 | 34 | 17 | 1929 | - | - | - |
| 1904 | 143 | 54 | 38 | 1930 | 627 | 203 | 32 |
| 1905 | 163 | 67 | 41 | 1931 | 461 | 101 | 22 |
| 1906 | 161 | 60 | 37 | 1932 | 534 | 178 | 33 |
| 1907 | 180 | 54 | 30 | 1933 | 565 | 173 | 31 |
| 1908 | 191 | 57 | 30 | 1934 | 610 | 177 | 29 |
| 1909 | 199 | 49 | 25 | 1935 | 515 | 119 | 23 |
| 1910 | 163 | 38 | 23 | 1936 | 570 | 108 | 19 |
| 1911 | 188 | 63 | 33 | 1937 | - | - | - |
| 1912 | 162 | 38 | 23 | 1938 | - | - | - |
| 1913 | 207 | 59 | 28 | 1939 | - | - | - |
| 1914 | 203 | 58 | 29 | 1940 | - | - | - |
| 1915 | 215 | 50 | 23 | 1941 | - | - | - |
| 1916 | 211 | 58 | 27 | 1942 | - | - | - |
| 1917 | 314 | 89 | 28 | 1943 | 836 | 220 | 26 |

| Year | Working expenses (£) | Pumping expenses (£) | % | Year | Working expenses (£) | Pumping expenses (£) | % |
|---|---|---|---|---|---|---|---|
| 1918 | 387 | 99 | 26 | 1944 | 896 | 312 | 35 |
| 1919 | 371 | 123 | 33 | 1945 | 879 | 292 | 33 |
| 1920 | 403 | 129 | 32 | 1946 | 895 | 264 | 30 |
| 1921 | 482 | 175 | 36 | 1947 | 1022 | 317 | 3 |

Figure 3.4 shows the variation in the latter quantity from 1896 to 1947, and shows that the tendency from 1905 to 1910 was for the pumping expenses to fall sharply, from 43% to 23% Thereafter the value fluctuates but remains consistently lower than the percentage observed for the period before 1903.


**Figure 3.4: Pumping Expenses as a Percentage of Working Expenses, 1896-1927**

The profit of a company is completely determined by the revenue and the working expenses; profit is in fact the difference between the two. This means that both of these variables must be taken into account in an attempt to explain variation in profit, but they are not necessarily of equal importance. If the revenue varies only slightly, then the variation of working expenses will explain most of the variation in profit whereas if the revenue is the more variable of the two, it wilt tend to control variation in profit. Thus, we would expect that higher values of profit would tend to be as-

sociated with higher values of revenue, and lower values of working expenses. If the pumping expenses are important in the determination of total working expenses, then we would expect higher values of profit to be associated with lower pumping expenses.

Figure 3.5 shows the variation in revenue, total expenditure, pumping expenses and profit from 1896 to 1918; inspection of the curves suggests that up to 1918 variation in profit was largely determined by variation in working expenses.

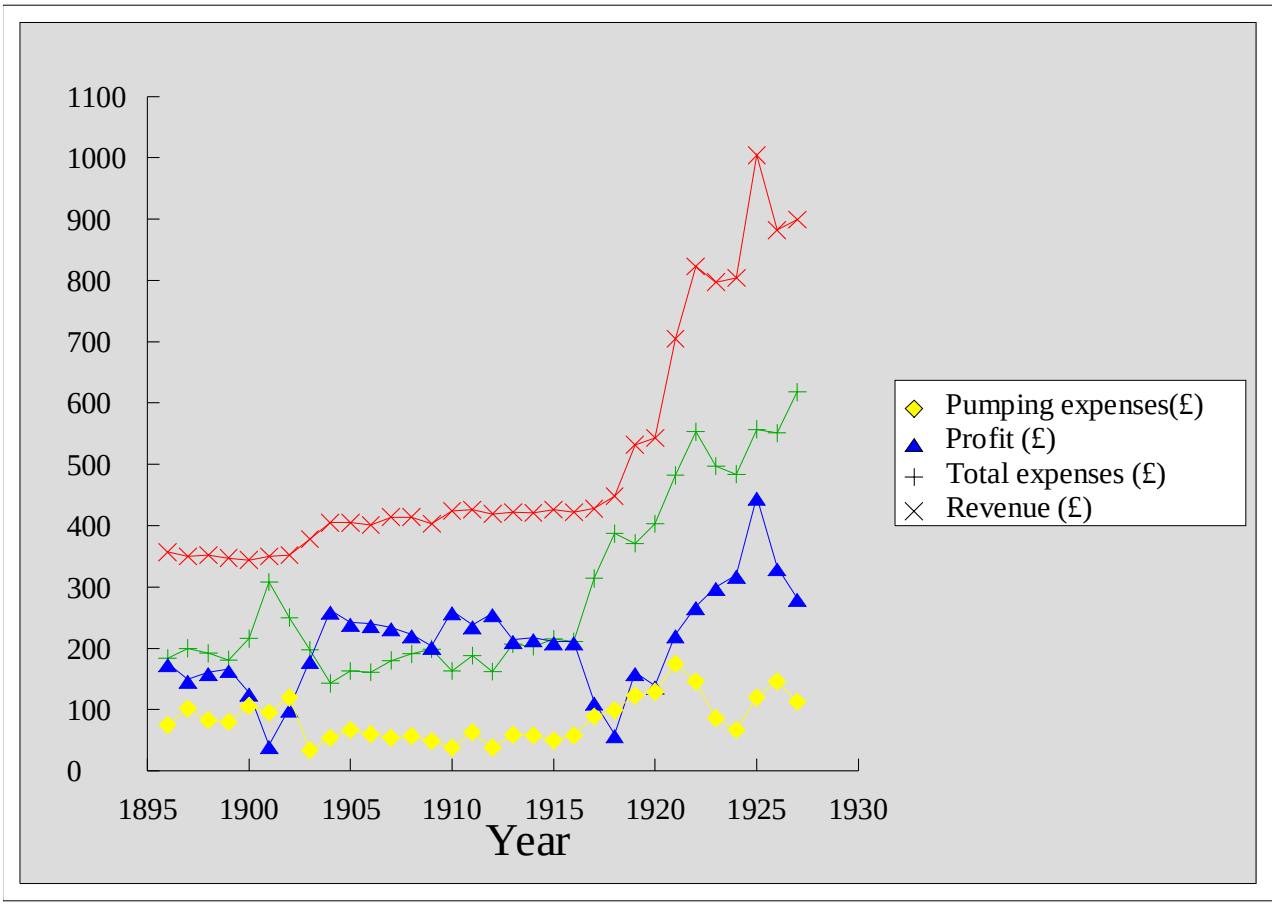


**Figure 3.5: Revenue, Expenditure, Profits and Pumping Expenses, 1896-1927**

Furthermore up to 1903, working expenses are greatly influenced by pumping expenses, but thereafter these become less important. The very good association between high values of total expenses and low values of profit is clearly shown. Also clear is the association between pumping expenses and profit before 1993, such that higher profits tend to be associated with lower pumping costs and vice-versa. The diagram also indicates the relationship between pumping costs and total expenses before 1903 and the fact that the association after that date tends to be in the opposite sense, that is low pumping costs being paired with high total costs instead of low ones. After 1903 in fact, the pumping costs form a lower proportion of total expenses, and are also less variable, and so have less influence on both profit and total costs. The relationship between pairs of variables of the sort we are concerned with here may be measured by the correlation coefficient calculated between a series of paired values. The more positive the value of the coefficient, the greater is the

tendency for higher values of the two variables in question to be paired together. Negative values indicate a tendency for large values of one variable to be paired with smaller values of the other.

In terms of the financial performance of a company, we would expect revenue and profit to correlate positively, and expenses and profit to correlate negatively. Over the whole 16 year period from 1896-1911, the Alcester Waterworks Company's profits produced a correlation coefficient of 0.852 with revenue, -0. 772 with pumping expenses, and -0.906 with total working expenses. Over the whole period then, variation in total expenses was the most important determinant of variation in profit, but there was a fairly strong relationship between profit and pumping costs. This must have been at least partly a consequence of the relationship between pumping costs and total costs, which produced a correlation coefficient of 0.599. If the two eight year periods (1896-1903 and 1904-1911) are considered separately, the following results are obtained:

| | **Period** | |
|---|---|---|
| **Correlation of profits with:** | **1896-1903** | **1904-1911** |
| Revenue | 0.418 | 0.255 |
| Pumping costs | -0.596 | -0.150 |
| Total costs | -0.972 | -0.872 |

Thus pumping costs correlate much less with profits in the second period than the first, Presumably pumping costs had fallen to the point where they exerted a much smaller influence over total costs than in the earlier period.

It was explained in Chapter 2 that the scheme proposed for the Alcester Waterworks Company involved pumping water from a well at Arrow to a reservoir on the hillside above, whence it would gravitate to the town. Power for the pumping was to be provided by a water wheel, fed by the waters of the Rock Mill stream, supplemented by the Spittle Brook, the latter being partially diverted from its natural course by an aqueduct constructed by the Alcester Waterworks Company.

The engineer consulted by the Company, John Millward of Birmingham, had expressed doubts about the feasibility of the scheme on the grounds of insufficiency of water power, and it soon became evident that the supply of water to operate the pumping equipment was inadequate, at least in some seasons. As early as 1882 for example, the Chairman's report to the Annual General Meeting of shareholders contains references to an intended new reservoir for storage of water for pumping.[18] This was to be constructed at a cost not exceeding £100, on land to be provided by Lord Hertford, who also agreed to pay one half of the cost. From 1886 onwards the Chairman's reports occasionally mention expense being incurred as a result of dry weather conditions. In 1886 for example it was reported that the sum of £30-10-9d (£30.54) had been spent on ‘the hire of an engine for pumping.’[19] Similar references may be found in the annual reports for 1888[20] and 1895[21] while in 1887[22] the shareholders are informed that no money had been spent on pumping which suggests that this was an event worthy of note.

Water power had clearly proved inadequate as the sole power source and the reasons for

this outcome are worthy of investigation. Two possibilities must be considered; either the engineer failed in the design of the waterwheel used to power the pumps, or the water supply to the wheel was deficient for some reason. No documentary evidence exists which will enable this question to be settled, but the industrial archaeology of the pumping station, in particular of the waterwheel itself can be made to shed light upon the matter.

The Alcester Waterworks Company built its pumping station in an abandoned quarry by the side of the Alcester-Evesham road. The site had probably been used for the exploitation of water power at some earlier date, being described in the Reference book deposited with the Clerk of the Peace as 'the site of the old Rock Mill'.[23] Nothing of the pump-house itself remains, for it was demolished in the early 1960's, but the waterwheel which powered the pumps still exists, and the leat, which fed the wheel with water from the Rock Mill stream and Spittle Brook, can be traced on the hillside above the wheel. Figures 3.6 and 3.7 show a plan of the pumping station site and a section through it with the wheel shown in its correct position to the same scale. Figure 3.8 is a detailed measured drawing of the water wheel itself. Plates 3.1 and 3.2 show the wheel from two different angles. It is clear from the arrangement of the buckets and the position of the wheel in relation to the water feed that the loaded buckets must have been on the side nearer to the leat. This means that the wheel must have been either of the high breast or pitchback type. Reports from older inhabitants of the town who can remember the waterwheel in operation indicate that the water was conveyed from the leat by a metal pipe or penstock and delivered high up on the circumference of the wheel just on the near side of top dead centre. Consideration of the section through the pumping station site (figure 3.7) suggests that this would have been a sensible arrangement; the difference in levels between the leat, and the top of the wheel is about right for a pitchback wheel. The form of the wheel itself, being narrow in relation to its circumference, is likewise what would be expected for the exploitation of a stream with a modest flow rate, but substantial fall, 4.57 metres, or about 15 feet, in this case.

From a knowledge of the mass of water present in each bucket (if the wheel were adequately supplied with water), the radius of the waterwheel, and the speed of its rotation, it is possible to make an estimate of the power output of the waterwheel from the visible evidence alone. Although the wheel is not in a workable state at present (1979), the buckets can be measured and counted and the speed of rotation estimated from millwright's rules in common use in the nineteenth century.[24] Appendix C shows how the power output of this particular wheel can be estimated by a combination of visible evidence from the remains of the wheel and some simple assumptions. The value thus obtained will simply be stated here as 2.30 kilowatt, or about three horsepower.

Thus the industrial archaeology of the pumping station site suggests that if fully supplied with water, the waterwheel would have produced about three horsepower at the wheel shaft after allowances for friction, splashing and other such incidental losses. Having obtained this value, it must be examined in the light of known design rules used by engineers working with water power in the late nineteenth century, to see whether the waterwheel built for the Alcester Waterworks Company by John Millward of Birmingham, was a reasonable design. In designing a waterwheel

the engineer needed to know the water flow rate of the stream to be used, and the vertical fall of water available. The stream flow was usually deduced from a knowledge of the catchment area which supplied it, the annual rainfall, and the presumed proportion of the rainfall which appeared as run-off in the stream. According to Edward Pritchard, an engineer active in a number of water schemes in the 1870's, it was usual to assume that about 34% of the rainfall appeared as run-off, the rest being lost by evaporation, seepage through the strata and so on.

No rainfall figures are available for Alcester for 1877, the year when the waterwheel was designed, but at Bidford-on-Avon, only three miles away, the precipitation amounted to 29 inches, or 0.737 metre.[26] Inspection of the 1:25000 Ordnance Survey map of the area shows the combined catchment area of the Spittle Brook and Rock Mill Stream to be $8.47 \times 10^6$ m$^2$ The calculation of flow rate would then proceed as follows :

(a) Total volume falling on the catchment per year :

$= 8.47 \times 0.737 \times 10^6$ m$^3$

(b) Volume appearing as run-off in the stream :

$= 8.47 \times 0.737 \times 0.34 \times 10^6$ m$^3$

$= 2{,}122{,}413$ m$^3$ per year

(c) Hence mean stream flow per second :

$= 2{,}122{,}413 \div (365.25 \times 24 \times 60 \times 60)$

$= 0.0673$ m$^3$ per second

In his classic work on mills and millwork, Sir William Fairbairn quotes a rule for estimating the power available from: a given stream by the use of the most efficient types of waterwheel. He states that 10.8 cubic feet of water per second would yield 1 horsepower for every foot of fall, after allowance for incidental losses. [27] Translated into S.I. units, this is equivalent to 8.036 kilowatt for lm$^3$ per second per metre of fall. Thus, using the flow rate calculated above and taking the fall as 4.57 metre we have :

Useful power obtainable from the water:

$=$ flow rate x fall x 8.036 kW

$= 0.073 \times 4.57 \times 8.036$ kW

$=$ **2.47 kW**

This figure is in reasonable agreement with that derived from the industrial archaeology of the waterwheel itself (2.3 kW) and suggests that the wheel was designed in accordance with the best practice of engineers at that time; the appearance of the wheel itself supports such a conclusion. The wheel rims are of cast iron, separate segments being bolted together to make the complete circumference, and these are supported on slender wrought iron spokes which are slotted into a cast iron hub. The wheel shaft is supported in gunmetal bearings which are provided with oil boxes for effective lubrication. The whole structure is in fact a good piece of late nineteenth century engineering work.

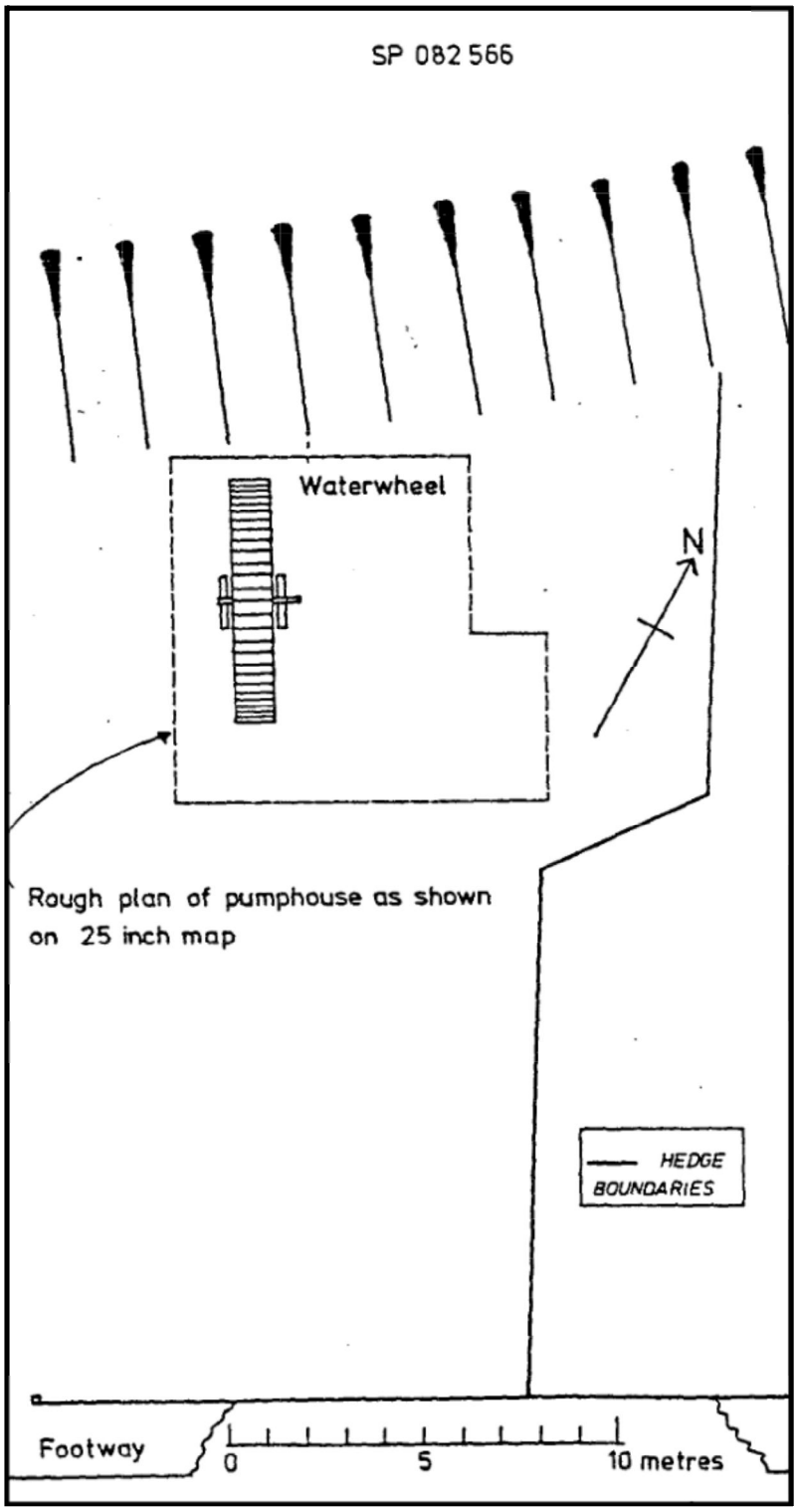


**Figure 3.6: Alcester Waterworks – site of pumping station**

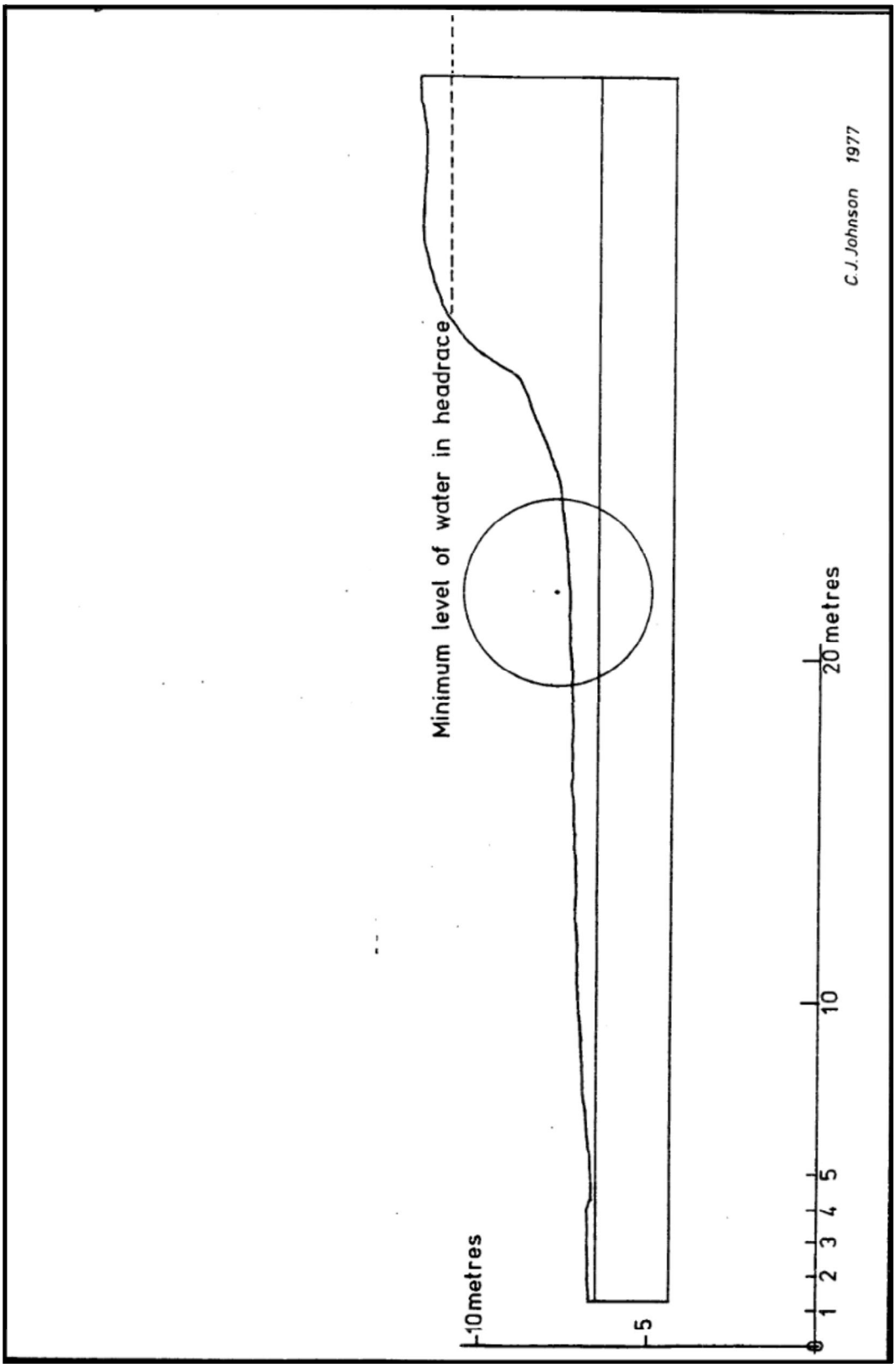


**Figure 3.7: Section through pumping station in the plane of rotation of the wheel**

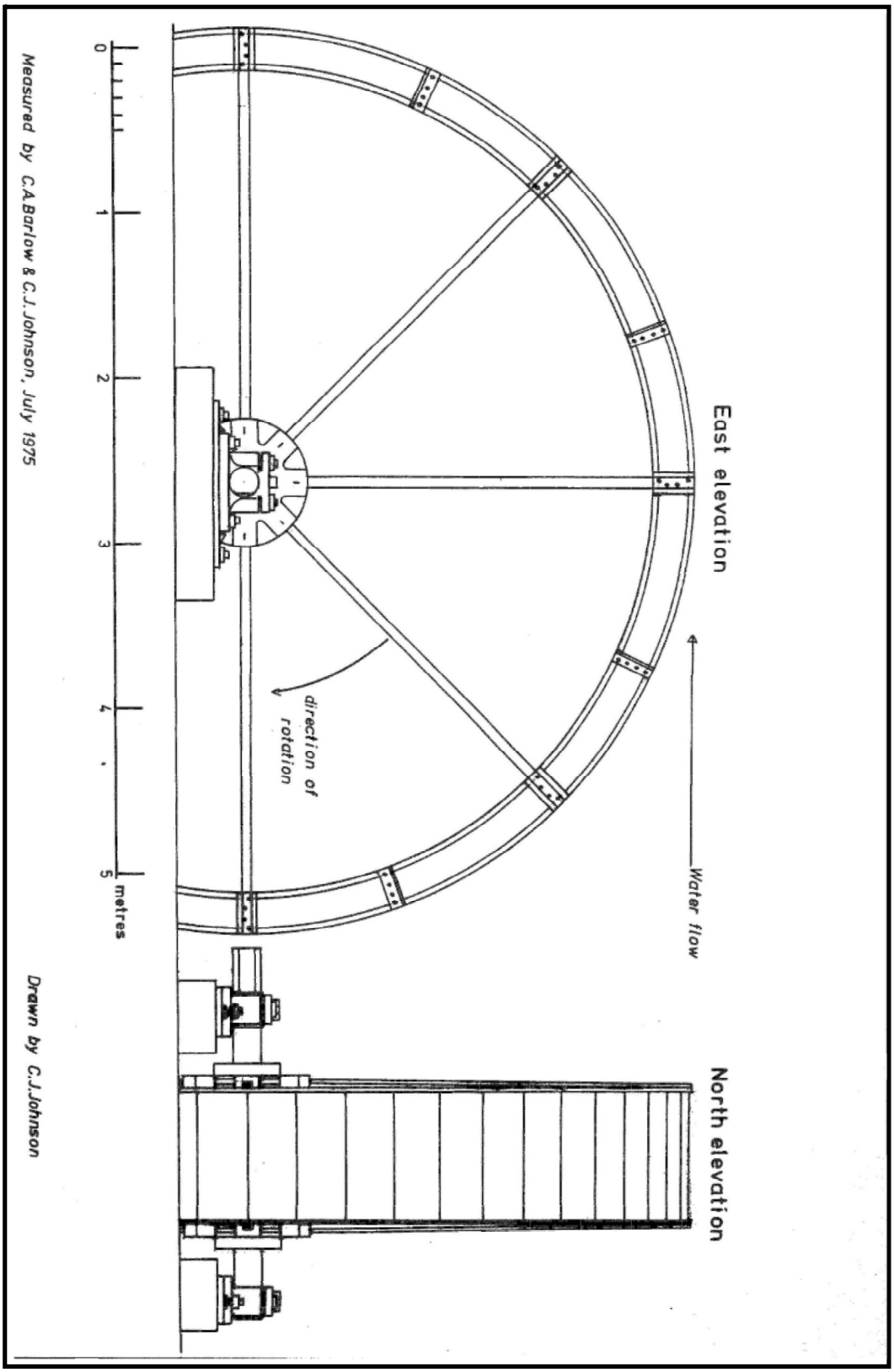


**Figure 3.8: The Alcester Waterworks Company's Pumping Wheel at Arrow**

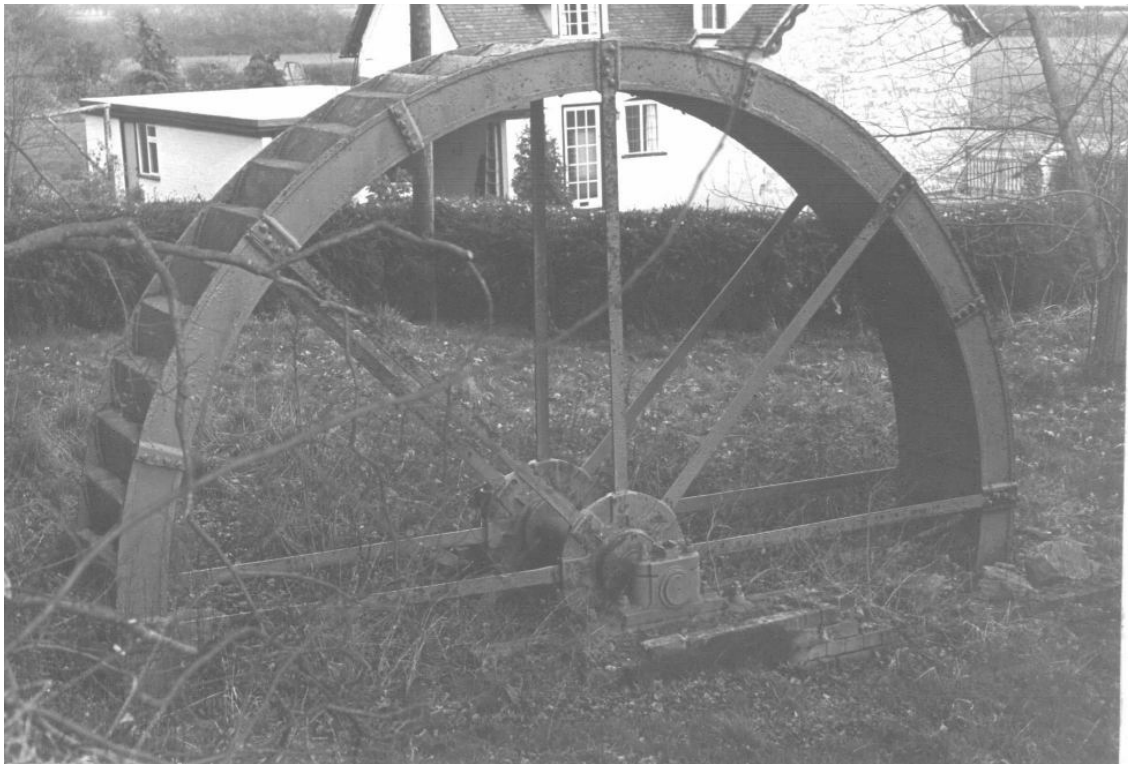

Plate 3.1: The Arrow pumping wheel from the west. The pumps were attached on the east side

Plate 3.2: The wheel from the South. Note the slender spokes and sophisticated bearings with oil boxes. The water came over the steep bank behind the wheel

Nonetheless the wheel did fail to fulfil the task required of it, and since the design would seem to have been adequate, on the basis of the evidence presented above, it is necessary to see whether the wheel, although fully exploiting the power available in the water would still have produced insufficient power for the pumping duty required of it. The Engineer, Millward, had assumed the daily water requirement of the town to be between 40 and 50 thousand gallons. This quantity would need to be raised each day through the distance between well and storage reservoir, This is 28 metres in round figures, so taking the acceleration due to gravity as 9.8 metres per second per second we have :

Work needed to be done on the water

= mass x distance x acceleration due to gravity

= $1.82 \times 28 \times 9.8 \times 10^5$ joule

= $4.99 \times 10^7$ joule

This is on the assumption that the lower of the two values (40 thousand gallons )was pumped, this being $1.82 \times 10^5$ kg of water. Power is the rate of working, so allowance must be made for the time taken to do the pumping. Millward allowed for a working day of 10 hours, so

Rate of working, or power:

= $4.99 \times 10^7 \div (10 \times 60 \times 60)$ watt

= 1370 watt

= 1.37 kW

This is the power to be applied to the water by the pump, so the wheel would have needed to supply more than this to allow for the losses due to friction, leakage, etc., in the pump itself. It is not easy to quantify these losses; much would have depended on the standard of maintenance and so forth, but one authority has suggested 80% as a typical value for the hydraulic efficiency of positive displacement reciprocating pumps of the kind used by the Alcester Waterworks Company.[28]

Assuming this to be correct, then :

Power needed at the crankshaft

= $1.37 \times 100 \div 80$

= **1.71 kW**

Comparing this with the designed power output estimate given above as 2.30 kW, we see that the wheel should have been equal to the pumping task required of it, al though the allowance is by no means generous. On the other hand the Alcester Waterworks Company was supplying no more than 31 thousand gallons daily as late as 1915, which implies a power requirement of as little as 1.31 kW or little more than 50% of what the wheel should have been capable of supplying.[29]

To summarize all these arguments, it has been shown that evidence from industrial archaeology enables us to estimate the designed power output of the waterwheel, and this seems to be in broad agreement with what might be expected on the basis of the stream flow calculated from rainfall data for the area. Furthermore the power output should have been adequate, though by no means generous for the pumping duty required. Why then did the water powered pumping

scheme fail? Presumably because the streams which fed the wheel were unable to furnish the flow rate which the engineer had assumed in his design calculations. The failure of the scheme implies an insufficiency in the water supply of the Rock Mill Stream and Spittle Brook which jointly fed the waterwheel at the pumping station.

The whole problem in fact illustrates one of the weak spots of water supply technology in the nineteenth century, namely the very theoretical approach to stream flow estimation.[30] Flow rates were normally inferred from the catchment area and rainfall as shown in the example above, with an assumed percentage of run-off. This approach is now known to be suspect for a number of reasons, partly because the run-off percentage is a very variable quantity and partly because the rainfall is unevenly distributed through the year, It is not enough to know the average stream flow, even if the run-off percentage were correct; some knowledge of the variation in flow rate about the average is needed for effective design. Modern hydrological practice is to measure stream flow rates empirically over a long period of time, so as to obtain a very clear picture of the pattern of stream flow variation.

Such a process is expensive and time consuming of course. Nothing of the sort was attempted by Millward when he designed the pumping scheme for the Alcester Waterworks Company. In fact he only visited the town once or twice, and only made one gauging of the streams involved; indeed his statement to the Waterworks committee in 1877 makes it clear that he had deduced the average stream flow from catchment area and rainfall as described above. On the other hand he was obviously aware of the effects of stream flow variation, pointing out that whereas the average flow rate of the Rock Mill Stream had been calculated at 500 gallons per minute, it had been gauged at 150 gallons, and would in very dry periods very likely drop below that.[31] To do the engineer justice, he had recommended steam power for pumping, presumably because he realised that the average flow rate was not sufficiently great to cover periods when rainfall was low.

Nonetheless the water powered pumping scheme was put into operation with Millward's design and it ran into difficulties presumably because the uneven distribution of rainfall through the year meant that in some months more rain fell than the company could store in the mill pounds and in others there would be insufficient to work the wheel. The failure of the water powered pumping scheme must be attributed in part to a deficiency in hydrological techniques, but partly also to the action of the Waterworks Company in insisting upon water powered pumping against the opinion of its engineer.

Once the waterwheel had been shown to be inadequate the Company was forced to adopt a supplementary power source and the cash book shows in 1885 a payment made for ‘a pulley for engine for driving’ and further payments for ‘hire of an engine’ and ‘coal for engine.’ These are the first references to any payments of this kind in the Company's account books and it must be presumed that they indicate the introduction of a steam engine to assist the waterwheel in driving the pumps. It seems to have been hired from the local farmer when needed and was presumably either a ‘portable’ engine or a traction engine; eventually the Company bought an engine of its own. After 1885 steam power was used every year until 1903, with the single exception of 1886, and

substantial sums (by the Company's standards) were spent in this way. Table 3.8 shows the amounts spent annually over this period.[32]

**Table 3.8: Annual Expenditure on Steam Power, 1885-1902** (From the Company's Ledgers)

| Year | Expenditure (£) | Year | Expenditure(£) |
|---|---|---|---|
| 1885 | 30.53 | 1894 | 43.07 |
| 1886 | 0.00 | 1895 | 10.6 |
| 1887 | 25.66 | 1896 | 72.60 |
| 1888 | 45.93 | 1897* | 102.94 |
| 1889 | 67.63 | 1898 | 70.45 |
| 1890 | 49.15 | 1899 | 74.60 |
| 1891 | 119.15 | 1900 | 92.55 |
| 1892 | 62.08 | 1901 | 57.60 |
| 1893 | 47.55 | 1902 | 68.59 |

*The figure for 1897 includes repairs to the engine and hire of a replacement.

In 1902 the Company bought a gas engine for pumping purposes at a cost of £95.46 and sold the old steam engine for £17.00.[33] It is clear that the directors hoped to obtain a reduction in pumping expenses in this way, and they were not disappointed, for the cost of pumping did fall in the succeeding years, partly as a result of the use of the more economical power source.[34]

The first effective form of internal combustion engine was the free piston engine devised by Dr. N. A. Otto of Cologne which used an explosion of a mixture of coal gas and air to create a partial vacuum in a closed cylinder, the power stroke using atmospheric pressure to return the piston to its starting point.[35] Rather inefficient because the power of the expanding gases was not used directly and extremely noisy, the free piston engine was superseded in 1876 by the fourstroke gas engine, also the work of Otto, but using principles laid down by Beau de Rochas in 1862.[36] This worked on what has come to be known as the Otto cycle of induction, compression, ignition and exhaust. The four-stroke cycle eventually displaced all the others except the later two-stroke cycle, and the Otto gas engine was the parent of all modern internal combustion engines.

Soon after the Otto four-stroke engine was introduced in 1876 the English firm of Crossley Brothers secured commercial exploitation rights of the invention for the whole world (Germany excepted) and soon became the leading manufacturers of this new and very effective power source, for in the first seventeen years of manufacture no less than 50,000 Otto cycle engines were sold, the vast majority of these by the Crossley concern.[37] It was from this firm that the Alcester Waterworks Company obtained its engine.

For small power outputs[38] the gas engine offered a number of advantages over the steam engine, particularly for intermittent rather than continuous duty. Not only was its thermal efficiency higher, that is it was able to convert a larger proportion of the potential energy in its fuel into

useful work, but it was also more flexible, being easier to start and stop than a steam engine, which needed a large labour input for fire raising and drawing, boiler washing and the like.

As well as having all these points in its favour, the gas engine was also very compact in relation to its power output, and could be installed where space was restricted. Needing only a supply of town gas, or its own gas producer[39] if this was not available, the gas engine was soon powering small workshops, factories and pumping installations throughout Great Britain, and rapidly displaced the steam engine for these purposes.

It is possible to gain some idea of the advance of the gas engine, and of attitudes to it, from entries in 'The Gas World', the journal of the gas industry. An article on the gas engine in 1887 for example stated that its efficiency had increased from 4% in 1860 to 18% in 1886 and compared this with figures for the largest steam engines with efficiencies of 12%, and small ones with efficiencies of 4-5%.[40] The gas engine was obviously not regarded as wholly acceptable even at this time for in 1888 a comment on an improved gas engine design by a Mr. Guthrie stated that 'If it succeeds the gas engine will be able to take the place of the steam engine in every respect and will be almost equally amenable to regulation.' [41] Evidently gas engines were not easy to sell, for it was reported in 1888 that the 'American Gaslight Journal' stated that 'Gas Companies should give purchasers three months trial, charging only for the gas, since many were deterred from purchasing by the first cost.'[42] Apparently it was supposed that use of the device would convince the users of the advantages. By 1894 however, the gas engine was said to have 'Established a secure position in the industries of the world' and to have had its efficiency raised to over 28%.[43]

The first gas engine to be installed in Alcester, of which there is a record, started work sometime in the late 1890's in the premises of a cycle manufacturer, [44] and at least twelve other engines were eventually at work in the town, powering concerns as diverse as a slaughterhouse, a printing establishment, a laundry and a sewage works. The Alcester Waterworks Company's engine was installed late in 1902, so that its first effective year of operation was 1903. Its power output is not known, possibly it was of the order of seven horsepower, which would have given a comfortable margin for operating the pumps.

The old steam engine had driven the pumps by a belt pulley on the drive shaft of the pumps, and the same system was used for the gas engine at first, although some new gearing was introduced, presumably to allow for this different rotational speed of the new engine. On the other hand the gearing may have been needed because the radii of the flywheels of the two engines differed, for both drove the pumping machinery by a flat belt from the flywheel. It seems that application of power from the gas engine was rather inefficient at first, the engine having to rotate the waterwheel as well as drive the pumps, but in 1904 a clutch mechanism was introduced which enabled either gas engine or waterwheel to be used alone as a power source, or both together.[45] The usual practice was to use the gas engine during the day, and the waterwheel at night; only very rarely were they both used at once.[46]

It is of interest to examine the records of the company for evidence of a fall in engine operating costs as a result of the introduction of the gas engine. Table 3.9 below shows fuel costs,

wage costs and total of the two from 1896-1927.

**Table 3.9: Wage and Fuel Costs, 1896-1927** From the Company's ledgers

| Year | Fuel (£) | Wages (£) | Total (£) | Year | Fuel (£) | Wages (£) | Total (£) |
|---|---|---|---|---|---|---|---|
| 1896 | 26.65 | 45.95 | 72.60 | 1912 | 5.97 | 28.98 | 34.95 |
| 1897 | 14.15 | 53.95 | 68.10 | 1913 | 21.68 | 32.13 | 53.81 |
| 1898 | 26.60 | 43.75 | 70.35 | 1914 | 22.05 | 34.70 | 56.75 |
| 1899 | 26.43 | 48.20 | 74.63 | 1915 | 15.99 | 32.50 | 48.49 |
| 1900 | 42.80 | 49.75 | 92.55 | 1916 | 20.10 | 33.70 | 53.80 |
| 1901 | 41.87 | 15.73 | 57.60 | 1917 | 45.43 | 37.88 | 83.81 |
| 1902 | 3.79 | 39.00 | 42.79 | 1918 | 52.53 | 38.43 | 90.76 |
| 1903 | 5.03 | 25.75 | 30.78 | 1919 | 65.31 | 53.10 | 118.41 |
| 1904 | 15.93 | 26.50 | 42.43 | 1920 | 71.02 | 53.20 | 124.22 |
| 1905 | 25.43 | 28.90 | 54.33 | 1921 | 69.42 | 56.30 | 125.72 |
| 1906 | 20.22 | 29.45 | 49.67 | 1922 | 75.86 | 59.40 | 135.25 |
| 1907 | 20.09 | 31.11 | 51.20 | 1923 | 22.77 | 53.48 | 76.25 |
| 1908 | 24.1 | 29.45 | 53.55 | 1924 | 7.28 | 57.98 | 65.26 |
| 1909 | 16.85 | 29.25 | 46.1 | 1925 | 50.77 | 60.87 | 111.64 |
| 1910 | 8.20 | 29.09 | 37.29 | 1926 | 44.75 | 63.76 | 108.51 |
| 1911 | 26.72 | 31.48 | 58.20 | 1927 | 39.60 | 67.45 | 107.05 |

Wages values for 1921 and 1925 have been interpolated

The figures representing fuel costs in table 3.9 are for coal up to and including 1902; thenceforth they represent payments for gas. At first sight the figures do not seem to show any striking evidence for a reduction in total costs, but two points must be borne in mind when attempting to interpret the data. The first is that the fairly sharp drop in fuel costs after 1902 was to some extent offset by a less marked fall in wages costs, which soon began to rise more steadily. This effect is shown in figure 3.9, which is a graphical illustration of the variation in the cost of fuel and labour from 1896 to 1927.

The other point to consider is that whereas the steam engine was only used in emergencies, that is when the waterwheel could not cope with the pumping duty, the gas engine was used on a regular day to day basis, so that the slightly smaller total cost after 1902 represents a larger amount of work being done. The evidence then is not incompatible with a fall in energy and labour costs as a result of the introduction of the gas engine in 1902.

As with all the other financial statistics discussed in this chapter, wages and fuel costs underwent a rapid inflation around 1916, and this process continued after the First World Far ended. In general gas costs tended to be much more variable than wage costs possibly because of the gas company' s pricing policy, or maybe because of variations in power demand.[47]

The gas engine remained at work until the end of the Company's existence without re-

placement, a tribute to the standard of construction which Crossley Brothers attained. Sums were spent on repairs from time to time of course, but the engine was never replaced by an entirely new one.

When the deficiency of the Company's supply became pressing in the 1930's and plans were made to tap a spring in the hamlet of Kinwarton, a little to the east of Alcester, electricity was available and was used as the power source for pumping. The brick pumphouse still stands (in 1979), with the electric motor and pumping gear still intact. The motor was rated at 4.9 brake horsepower and drove the pump through V belting and spur reduction gearing. The force pump, by

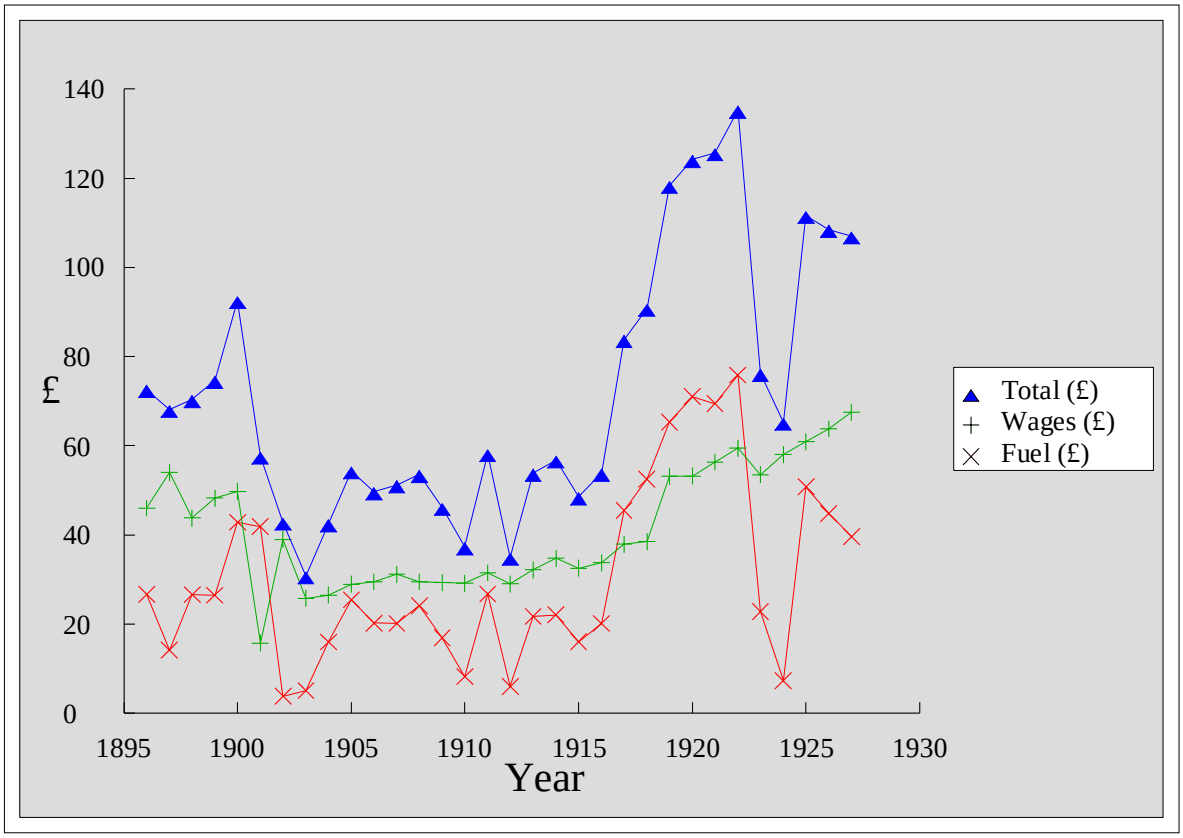


**Figure 3.9 Wage and fuel cost for pumping, 1896 - 1928**

Joseph Evans of Wolverhampton, was fitted with an air reservoir to smooth out pressure variations had a stroke of 12 inches and a bore of 4 inches, The gear was controlled by an electric time switch and was presumably intended to be fully automatic.[48] Simple, but effective, the installation remained in use until 1965, having by then passed from the ownership of the Alcester Rural District Council to that of the East Worcestershire Waterworks Company. The Alcester Rural District Council had taken over the plant in 1948 when the Alcester Waterworks Company was wound up. Figure 3.10 is a plan of the Kinwarton pumphouse.

So for the last ten years of its existence the Alcester Waterworks Company operated two pumping stations, the original one at Arrow and the later one at Kinwarton. The Arrow pumping station used gas as its main power source, but the waterwheel is believed to have remained in a

working condition, if not in operation, until the end of the Company's existence; money was certainly spent on clearing out the mill pounds in 1944.[49]

During this final phase of its life the Company was a secure and stable concern, paying handsome dividends on its ordinary shares which were accordingly much sought after. At least some of this success can be attributed to the gas engine, the new prime mover powered by town gas.

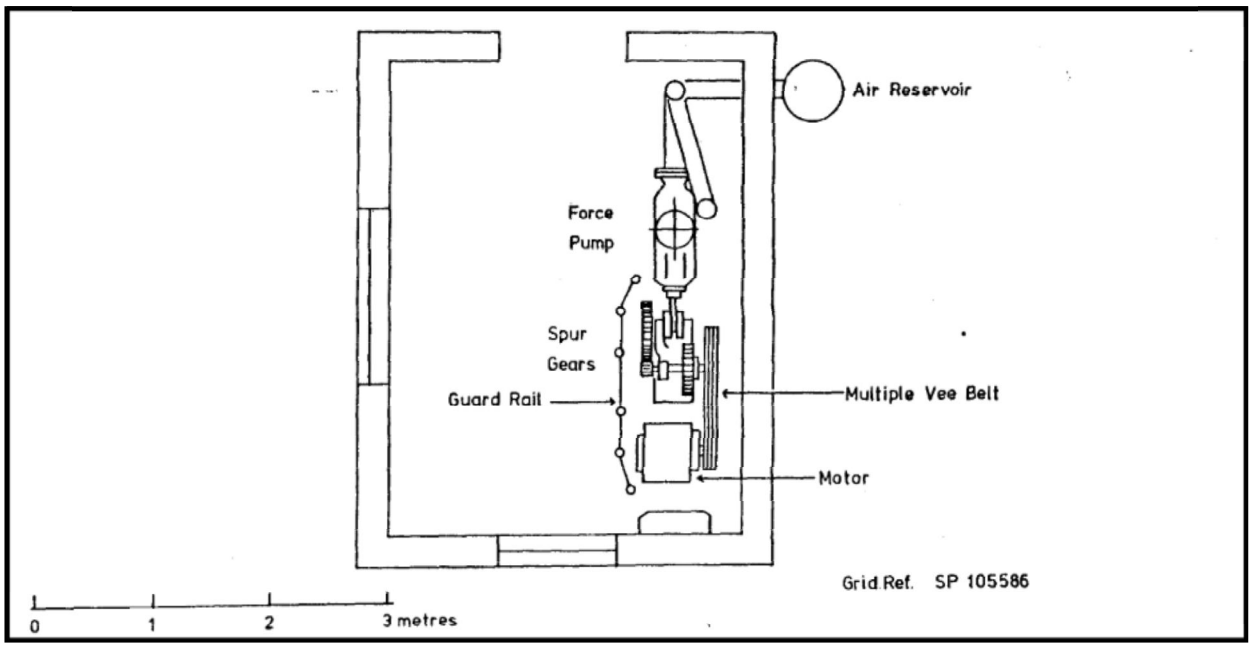


**Figure 3.10 : The Kinwarton pumphouse. Plan based on drawings in possession of The East Worcestershire Waterworks Company**

## Notes and References to Chapter 3

1. AC, 7th February 1885. Report of annual general meeting.
2. As late as 17th February 1879 only 371 of the 400 shares had been allotted, and some of these were later forfeited, since the capital account for 1896 shows only 360 ordinary shares. WR0, CR 114a/735/1 letter to shareholders, 17th February 1879 and WRO, CR 1547/353, ledger of Alcester Waterworks Company, 1896.
3. Op.Cit., note 2 above.
4. *Stratford-upon-Avon Herald*, 6th February 1881; report of annual general meeting.
5. AC, 10th February 1883.
6. In the end, the large proportion of capital held as preference shares benefitted the ordinary shareholders considerably, for once the Company was profitable, any increased surplus went to them, after the preference shareholders had received their 5%.
7. WRO, CR 1547/353; ledger of the Waterworks Company, 1896.
8. The new shares were sold in 1940 to help finance the Company's exploitation of the new spring at Kinwarton to the east of the town. They were sold at a premium, £5 shares selling for £6, which is an indication of the financial standing of the Company at this time. WRO, CR 1547/356, Alcester Waterworks Company's Cash Book, October 1940.
9. AC, 7th February 1885; report of the annual general meeting.
10. *Redditch Indicator*, 6th February 1886. Report of annual general meeting.

11. AC, 11th February, 1905; report of annual general meeting.
12. AC, 10th February, 1906; report of annual general meeting.
13. AC, 8th February, 1913; report of annual general meeting.
14. The dividends listed are those for the trading year from which they resulted, not the year in which they were declared. Dividends were announced in February every year on the results of the activities in the year ending the previous December.
15. A 10% dividend must have been encouraging for shareholders nonetheless, when bank rate was around 3%, in the post war 'cheap' money' era.
16. The figures were obtained from the Company's Ledgers, 1896-1947. The volumes for 1928-42 are missing; figures for 1930-36 have been obtained from annual balance sheets found in the register of shareholders. WRO, CR 15147/352/353/354/355.
17. The Company's revenue was largely derived from water rent payments, but there were small contributions annually from bank interest and refund of county court fees.
18. AC, 11th February 1882. The reservoir was to be situated in 'miry meadow' a site which has yet to be identified. The remains of a reservoir is still to be seen in Old Park Wood (SP 064591) high on the eastern flank of the Ridgeway. This is not shown on the Company's deposited plans, so was either there before 1878, or was constructed after the other works, It supplied water to the Rock Mill Stream, which was thus used for pumping, but it seems unlikely that miry meadow would have been in a wood. The reservoir was no longer in use by 1910.
19. *Redditch Indicator,* 6th February 1886; report of annual general meeting
20. *Stratford-upon-Avon Herald*; report of annual general meeting.
21. AC,9th February, 1895; report of annual general meeting.
22. *Stratford-upon-Avon Herald,* 11th February 1887; report of annual general meeting.
23. WRO, CR 1481/2.
24. See Glyn, J.F. (F.R.S.) : *A Rudimentary Treatise on the Power of Water as Applied to Drive Flour Mills and to Give Motion to Turbines and Other Hydrostatic Engines*, 5th edition, Longmans, London 1875, page 82.
25. 'From practical observation etc. by most eminent engineers .....about 34% of rainfall could be collected in reservoirs, etc., the remaining 66% being lost by evaporation'; Pritchard, E.; *Report on the Proposed Water Supply from Haseley*, George Lacy, Warwick, 1873.
26. The rainfall figure for Bidford-on-Avon comes from the report of the Medical Officer of Health for 1877; ROW, B.A. 837, 250-2.
27. Fairbairn, Sir William; *A Treatise on Mills and Millwork*, 4th edition, Longmans, London 1878, page 121.
28. Adams, H. C.; *Waterworks for Urban and Rural Districts,* 1st edition, Pitman, London, 1922, page 68.
29. This figure comes from *The Return as to Water Undertakings in England and Wales,* H.M.S.O., 1915.
30. This point is discussed at some length in Smith, K.; *Water in Britain: A Study in Applied Hydrology and Resource Geography*, Macmillan, London, 1972, page 17.
31. AC, 12th May 1877. Report of proposed new water supply for Alcester
32. The figures have been obtained from the Company's Cash Book prior to 1896, and from the Ledgers afterwards. WRO CR 1547/ 356/ 353.
33. Entry in the Company's Cash Book, November 1902, WRO, CR 1547/356.
34. AC, 6th February 1904. In the annual report to shareholders the chairman looked forward to a reduction in pumping expenses' as a result of the introduction of the gas engine.
35. The free piston engine, and the attitude of engineers towards it are described in Rolt, L. T .C.; *The Mechanicals - Progress of a Profession*, Heineman, London, 1967, pages 76 and 77.
36. Ibid, page 78.
37. For an interesting but brief account of the Crossley firm see Short, C. C. : *A Lancashire Pioneer: Crossley Brothers and the Pre-history of Crossley Motors;* Industrial Past, Spring 1978.
38. Eventually gas engines with a power output as high as 5000 horsepower were produced. Derry T. K. and Williams T. I.; *A Short History of Technology from Earliest Times to A.D. 1900*; Oxford University Press,

London 1960, page 603.

39. Engines used on sites remote from town gas supplies used producer gas a mixture of carbon monoxide and nitrogen from a coke fired gas generator. For a description of such an engine, used to power a stone saw in a quarry on Iona see Viner, D.J. ; *The Marble Quarry , Iona, Inner Hebrides* ; Industrial Archaeology Review, 1978, 1,1, 18-27.

40. *The Future of the Gas Engine*; The Gas World, 24th December 1887, page 812.

41. The Gas World, 4th April 1888, page 403.

42. The Gas World, 1st December 1888, page 596.

43. The Gas World, 17th November 1891:, page 581.

44. WRO, CR 939; Minutes of the Alcester Gaslight and Coke Company, 4th November, 1896.

45. A clutch mechanism of this kind was fitted when the gas engine was installed, and is mentioned in the Chairman's report in 1903 (AC, 7th February 1903), but it must have been ineffective, for a new one was constructed and fitted by a local blacksmith, F. Hayward. His time book is in the possession of the Alcester and District Local History Society, The clutch was constructed and fitted between September and November 1904.

46. Information on the use of the gas engine was obtained from Mr. Tolman, of Cross Lane, Alcester, whose father was in charge of the pumping engine at the Arrow pumping station. He was employed in a part time capacity. Mr. Tolman reports that the only time that both waterwheel and gas engine were employed together was when the Alcester Brewery was brewing a new batch of beer. The water demand was then heavy enough to require both power sources. The gas engine was started by swinging the flywheel; the waterwheel needed Mr. Tolman, then only a child, to stand on one of the buckets before it would start under load.

47. For example the Gas Company allowed a rebate of 6d (2½p) per 1000 cubic feet of gas used as from 1st July 1912. The Alcester Chronicle noted that 'those who used gas engines would be gratified with this news.' AC, 24th August 1912.

48. The information on the Kinwarton pumping installation is derived partly from information kindly supplied by Mr. Steed of the East Worcestershire Waterworks Company, and partly from the author's own inspection of the pumphouse.

49. WR0, CR 1547/355; entry in the Ledger for 1944.

## Chapter 4 : Water Sources, Distribution and Treatment

Bodies concerned with the provision of a public water supply in Britain have, in the main, depended upon three types of water source. Either the water was abstracted from a nearby river, or collected on an upland catchment area at some distance from the consumers, or it was pumped from deep wells, boreholes or springs to a holding tank or reservoir before being distributed by gravity in the usual way. The earliest schemes, such as those promoted by Sorrocold (see Chapter I) were usually river schemes. Such tended to fall out of favour during the nineteenth century as a result of the increasing awareness of the hazard to public health which river water frequently presented. Nonetheless a large proportion of London's water is still obtained from the Thames above Teddington weir, and river abstraction schemes have been coming back into favour in the last twenty years or so, partly as a result of an ever-growing demand for water combined with resistance to the submerging of yet more upland valleys beneath reservoirs. As an example of a river abstraction scheme of the modern type, the City of Coventry draws water from the River Severn near Upton-on-Severn, through an aqueduct fifty miles or so in length.

The upland catchment schemes were often the method used by engineers planning supplies for the new industrial towns in the nineteenth century. Manchester, Liverpool and Birmingham were supplied in this way, as were many towns on the fringes of the Pennines. Often the works involved were considerable projects by any standard, requiring the construction of large masonry dams and very long aqueducts; that which brings Birmingham's water from the Elan Valley in Wales for example, is over seventy miles long.

Borehole schemes have been less favoured at least by the larger concerns, although Nottingham was supplied in this way and Hull and Bristol were partly dependent on boreholes. Thomas Hawkesley was an engineer who was often involved in supplies from boreholes, and was responsible for Nottingham's scheme in the 1850's.

Before water is supplied to consumers it is normally subjected to various processes designed to remove undesirable constituents. These may be either material in suspension, or substances in solution, or pathogenic micro-organisms. The earliest treatment process to be developed was filtration under gravity through a bed of sand. According to Smith, Paisley was the first town in the world to enjoy a supply which had been treated in this way.[1] Although sand filtration was introduced simply to remove suspended matter, it was subsequently discovered that most of the pathogens were also removed if the water was not too contaminated.

The usual practice at present is to treat water with chlorine (or more rarely ozone) in order to destroy any pathogenic organisms not removed by filtration, particularly those responsible for cholera and typhoid fever. Normally liquid chlorine is injected into the water automatically, the injection rate being controlled by a device which monitors the chlorine concentration in the treated water. Ozone is injected as ozonized oxygen, the latter being produced at the treatment site. It has the advantage that it does not produce objectionable flavours from reaction with organic substances in the water as chlorine does.[2] The removal of soluble materials has only recently been considered, as increasing demand makes the use of lower grade sources necessary. Excessive con-

centrations of nitrate ion, resulting from the use of nitrogenous fertilisers on farmland, present a problem for which there is no simple remedy at present, but with which water suppliers will have to deal in the future.

Of the three types of sources discussed above, river water, especially if abstracted far from the origin, is likely to be the poorest. Upland catchment supplies usually contain suspended matter but little else, and borehole water is usually free from all but soluble matter, having been filtered by percolation through the strata as it accumulated.

The earliest plan for the supply of water to Alcester involved impounding the waters of the Spittle Brook at some distance above the town. After filtration the water would have gravitated directly to the consumers (the scheme was described in detail in Chapter 2). This was an upland catchment scheme on a small scale in fact. How this scheme came to be abandoned was outlined in Chapter 2; it was replaced by a proposal to draw water from certain springs in Oversley, lead it to a well and holding tank on the pumping station site, and raise it to a reservoir on the hillside above. Figure 4.1 is a plan of the scheme, based on the plans which the Company deposited with the Clerk of the Peace before making application for the Provisional Water Order under which it operated. The plan shows the proposed system of distribution mains, but it seems that the main to Arrow was not laid until 1911 or 1912,[3] and the mains in Alcester were extended beyond the simple system shown in figure 4.1 over the period from the Company's inception up to 1938.

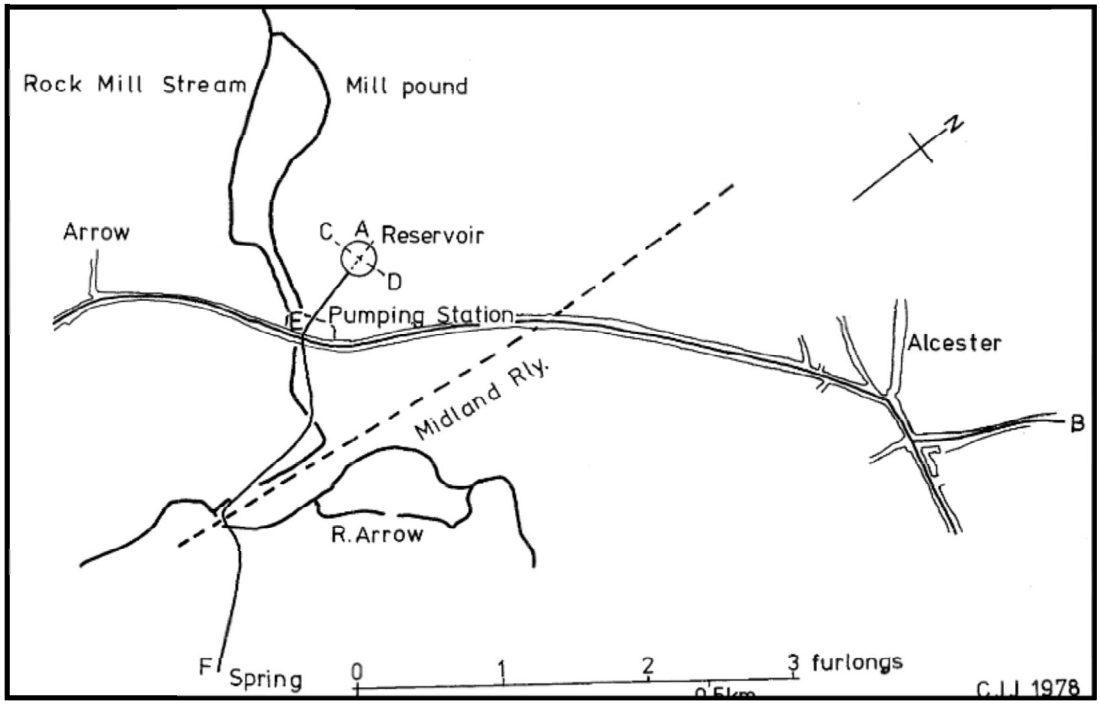


**Figure 4.1: Plan of Alcester Waterworks. Based on the Company's deposited plans, 1877**

The Oversley spring water was derived from the superficial gravel deposits on the banks of the River Arrow. The polluted wells in Alcester, which the scheme was intended to supplant, were sunk into similar deposits, but since the Oversley springs were remote from the human population they were unlikely to be polluted. The springs were were tapped by sinking perforated clay

pipes in the gravel at a depth of 6 to 8 feet and leading the water which entered the pipes into a collecting chamber. From the collecting chamber the water was led by a cast iron pipe to the pumping station. Figure 4.2 is a measured drawing of one of the two collection chambers. The collecting tank itself is of cast iron, with a concrete slab for a roof, and the chamber is fitted with 'Cowell's Patent Sanitary Ventilators'.

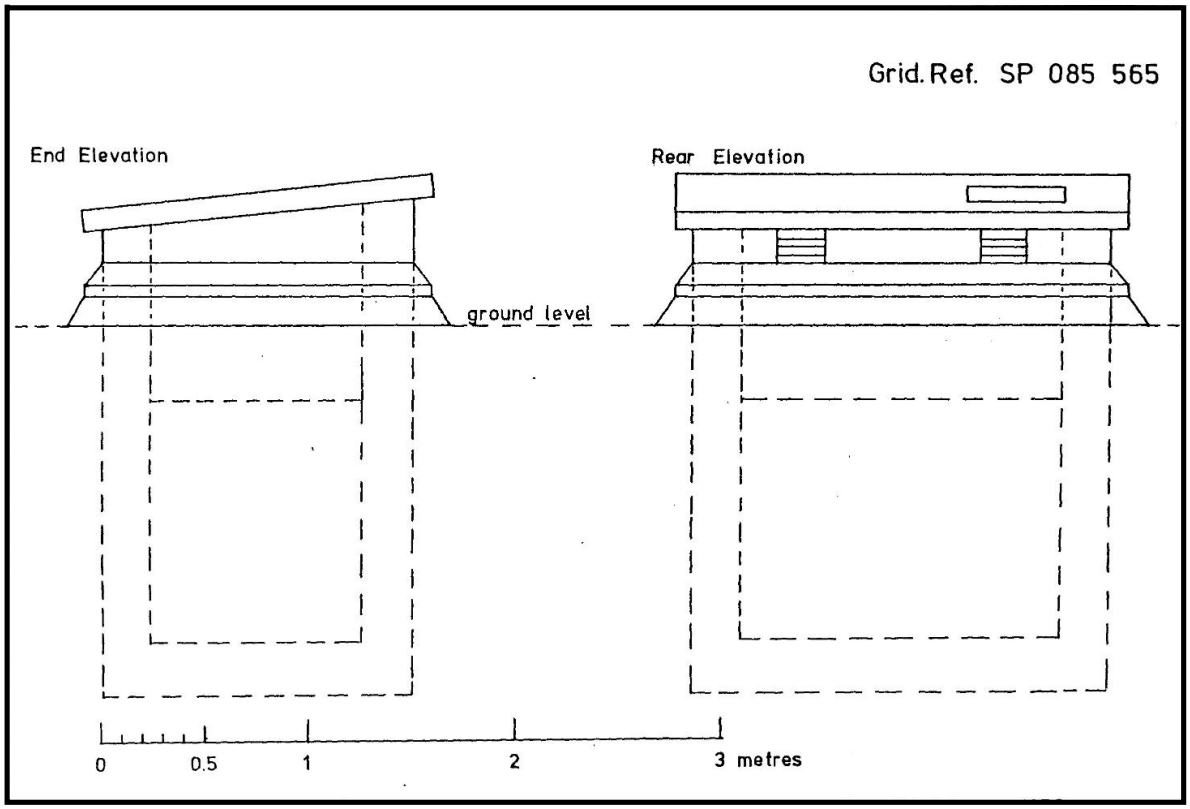


**Figure 4.2: Catchment tank at Oversley upper spring**

Figure 4.3 shows a section through the spring catchment system (also based upon the Company's deposited plans) and indicates that there were two springs in the Oversley gravel deposits. The plan however, suggests that the Company at first planned to use only one of them, the upper spring which is shown with a catchment tank on the section, figure 4.3. The Company found it necessary to tap the other as early as 1885; the Chairman's report for 1886 stated that 'A new spring had been connected with the works and had proved most useful.'[4] Since this spring was at a lower level than the first one, simply feeding its outlet pipe into the existing main would have produced difficulties; the water from the first spring would just have run out at the new spring instead of gravitating to the pumping station. This problem was solved by building the catchment tank high enough above. the spring to allow the water levels to equalize without water flowing from the ventilation holes on the lower tank.

The reservoir, on the summit of Grunt Hill, still exists. It is sunk into an earth mound on the hill top; the whole structure is surrounded by a cast iron fence. Figure 4.1 shows a plan and section through the reservoir. Since it was not possible to get inside the storage tank itself, the

internal arrangements are somewhat conjectural, being based upon the storage capacity given in *The Return as to Water Undertakings*.

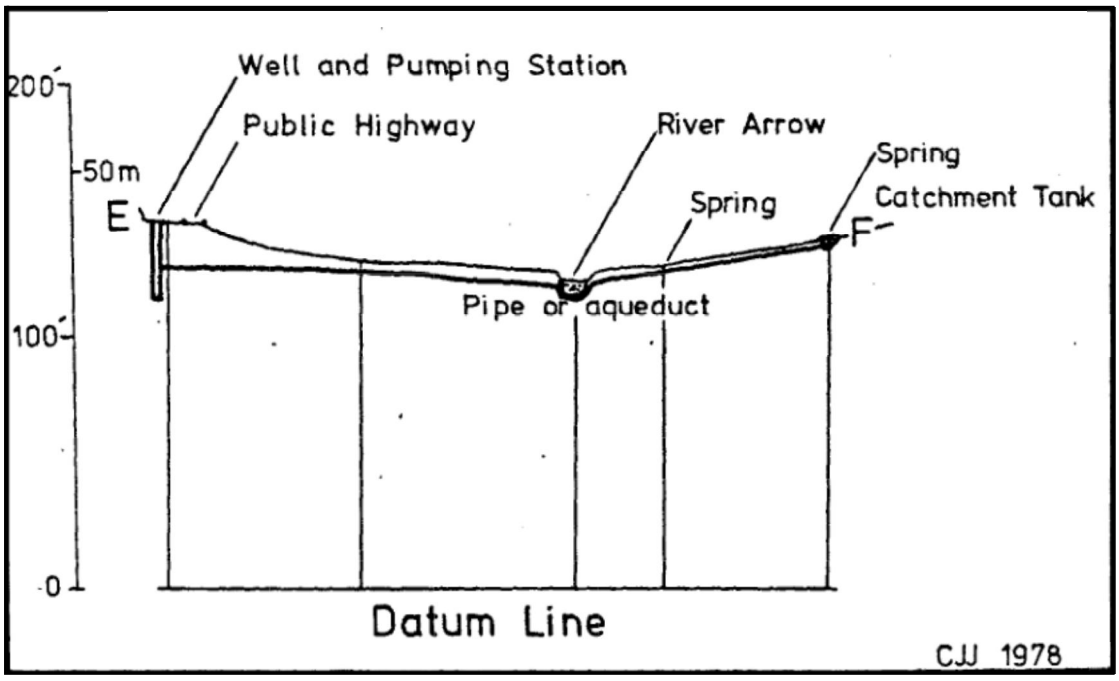


**Figure 4.3 : Alcester Waterworks. Section across catchment area**

A description of the Company's sources of supply in 1915 lists three, namely

(a) The well at Rock Mill

(b) A spring

(c) A borehole

all in the parish of Arrow.[5] The 'well' is the well/holding tank at the pumping station (which was built on the site of the old Rock Mill). Its yield is unknown, but in 1928 it was said to be 25 feet deep and 6 feet 6 inches (or 7.62 x 1.98 metre) in diameter and to 'tap a spring in the Keuper Marl'.[6] The Company had the well sunk on the site in its early days, and it was hoped that it would yield sufficient water in itself, but this hope was disappointed. Inspection of figure 4.3 will show that the well could never have much more than about half full, for the mouth of the well was above the level of the catchment tanks in Oversley, so had it been any higher water could have flowed back and escaped through the ventilators of the tanks.

The same report in 1928 described the borehole as 150 feet (or 45.72 metre) deep and also sunk into the Keuper Marl. It was sunk as a result of pressure brought upon the Company by the local authorities, first the Rural Sanitary Authority, and later the Alcester Rural District Council, which succeeded the Sanitary Authority as the body with responsibility for sanitary matters. As early as 1890 the Medical Officer of Health had informed the Rural Sanitary Authority that the Sanatorium was frequently without water from the town's supply.[7] In 1891 the Company asked the Sanitary Authority to order the closing of an unsanitary well on the premises of the Globe Hotel; it was suggested in the subsequent discussion that it was unreasonable to close wells if the Company

could not supply water in lieu.[8] Earlier in this year in fact the Clerk to the Sanitary Authority had been instructed to write to the Company complaining of deficiency in the supply, and threatening action under the Public Health Acts.[9] To this the Company replied somewhat mysteriously that 'The Waterworks Company kept a supply of water in the town.' The Rural Sanitary Authority again drew attention to shortcomings in the water supply in 1891[10] and 1896[11] and it seems clear that the Company's provision was inadequate.

Commercial pressures in fact ensured that the Company's main interest was in increasing the number of consumers connected to its mains, rather than in providing abundant water; only pressure exerted by local authorities was likely to be effective in making the Company ensure that it supplies were even adequate. Nonetheless the repeated complaints by the Rural District Council had some effect, for in 1896 the Company informed the Council that 'Steps had been taken by boring operations to remedy the situation' and the Council in reply asked for a guarantee that boring would continue until '..... a plentiful supply of water was secured.'[12] Some boring was carried out as the Company's Cash Book shows, the sum of £46 being paid to Thomas Baird for this purpose.[13] It is possible that Baird was simply deepening the existing well, but the sinking of a true, deep, borehole seems more likely. By the end of October 1896, the Company was able to inform the Rural District Council (rather optimistically as it turned out) that it had 'a large quantity of water', but that if necessary, boring would be resumed.[14] The townspeople continued to complain to the Medical Officer of Health about the supply however, and the Clerk to the Council was ordered at the end of July 1897 to inform the Company that 'in the event of a further complaint being received, the Council will proceed to exercise its powers to provide Alcester with a plentiful supply of water.'[15] No reply was received to this letter so on the 22nd of September the Clerk was ordered to call upon the Directors of the Company in person.[16] Those gentlemen responded to the Clerk's visit by advising their shareholders to sell the Company to the Rural District Council at 'par value' (£3900) with all expenses of the liquidation to be borne by the Council.[17]

This was quite an effective counterstroke, for the Council refused on the grounds of 'prohibitive costs', to take over the concern.[18] Probably the members of the Council had no idea of how to secure the plentiful supplies which they hoped for, and even less notion of running a waterworks on a day to day basis. The shareholders on the other hand would have been glad to dispose of their property at par value. As was shown in Chapter 3, the Company had reached the low point of its fortunes in the 1890's and it seems unlikely that the shares could have been disposed of on the open market on these terms. Things continued in this desultory way for some time with the Rural District Council complaining about the insufficiency of the supply, and the Company promising to do better, for some years. To show what the townspeople were annoyed about we may quote the Medical Officer of Health in 1900, who reported to the Council that '..... in the last year there has hardly been a day on which the water has not been turned off for some part of the day.' He regarded this as a danger to public health, since most of the consumers were without storage and would therefore have to resort to the polluted wells for essential drinking water, and suggested that pressure should be brought upon the Company to improve the supply.[19] Letters to the Company produced only the usual response however, and after more complaints from the consumers,

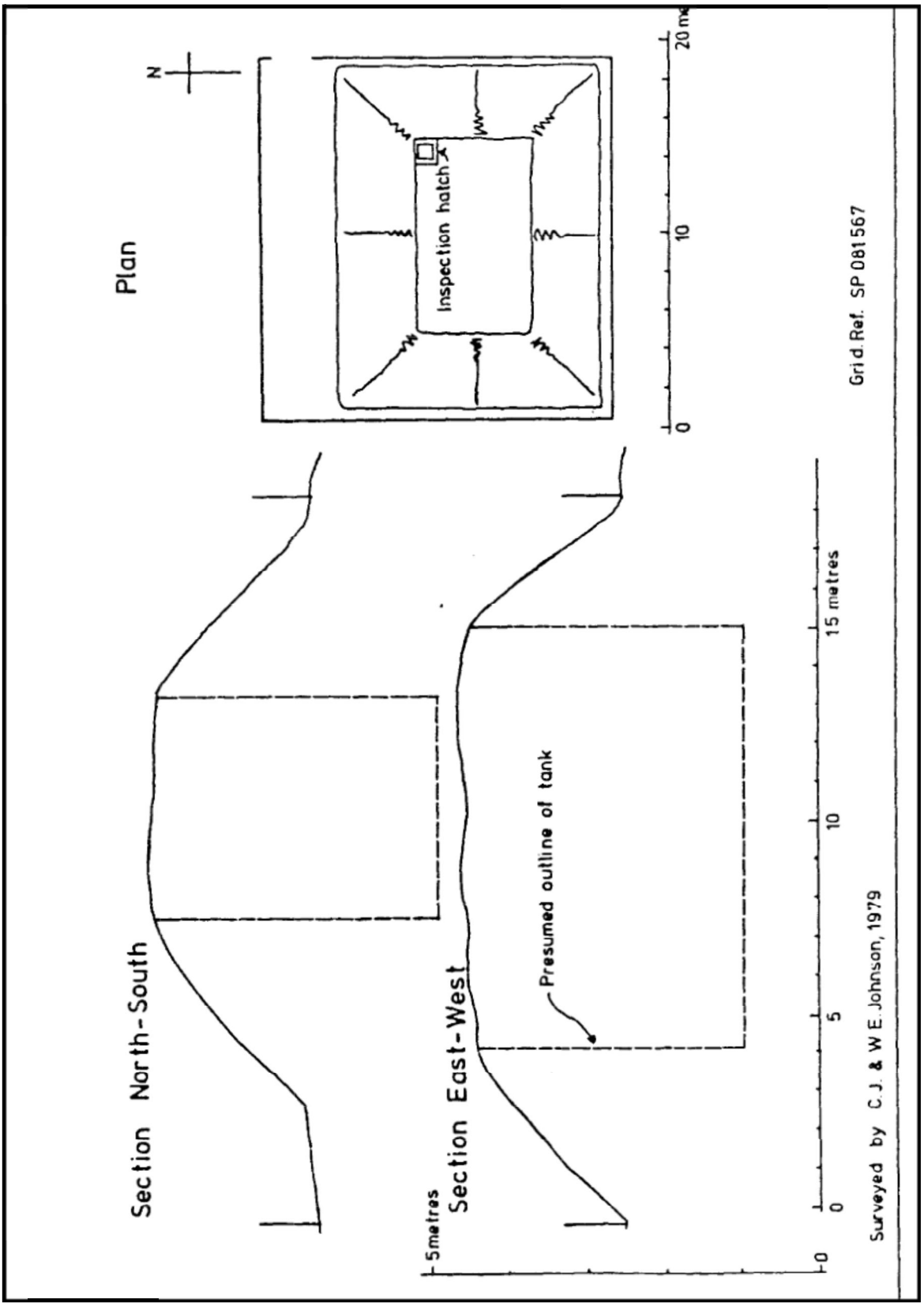


**Figure 4.4 : Plan and section of the storage reservoir**

the Rural District Council again suggested taking over the Company.[20]

In reply the Company claimed to have arranged ‘a twelve-hour supply to every house’ (which seems very modest) and suggested that further boring might be undertaken.[21] Eventually the Company promised to obtain a further supply and in 1901 boring was again in progress. This can only be in the Arrow borehole for in a letter to the Council it was stated that the boring was ‘270 feet down but the ground is so hard that boring had stopped for a time.’[22] Since the borehole was reported as 150 feet deep in 1928, it seems possible that the Directors of the Company were exaggerating so as to impress the members of the Council. In my event, the sum of £75 was spent on boring in 1901, and £10 in the next year.[23]

For some time after the completion of the borehole, the Company seems to have supplied the town adequately. The installation of the gas engine for pumping in 1902 improved matters somewhat, and complaints from citizens cease to feature in the minutes of the Rural. District Council for some years. Even so the Chairman's Annual Reports to shareholders frequently mention that the supply had been maintained throughout the summer, so this was clearly not to be taken for granted.

By 1917 however there were further reports of the defects of the supply, which was said to be ‘erratic and turned off without warning’[24] and in 1921 the Rural District Council, prompted no doubt by the forthcoming expansion of the town with the building of council houses, requested the Alcester Waterworks Company to :

(a) Increase storage from 30,000 to 100,000 gallons.

(b) Supply the town from storage, not by direct pumping.

(c) Arrange for continuing supply in the event of drought.

(d) Cover the storage reservoir.[25]

To these requests the Company replied that:

(a) Storage was already about 60,000 gallons (2 days supply )

(b) There was no advantage in a separate rising main from pumps to reservoir.

(c ) Duplicate pumps were already in operation.

(d) A new lid had been fitted to the reservoir.

These were all sensible replies, and after obtaining an assurance that the reservoir would be topped up daily, the Local Authority took no further action.[26]

No new sources of supply were obtained until 1935, when possibly as a result of the severe drought of 1934, the Company rented an artesian spring in School Road, Alcester.[27] This came from a borehole 80 feet deep into the Keuper Marl, which had been sunk as a test boring in 1877[28] and had been used by the Rural District Council for flushing the sewers.[29] The spring yielded around 10,000 gallons per day, and it is not clear exactly how it was connected with the rest of the system. In any case its exploitation was only a temporary expedient, for in 1938 the Company embarked upon its final attempt at the expansion of supply. This was the tapping of the Kinwarton spring. Figure 4.5 shows this new source and the School Road spring in relation to the

sources in Arrow and Oversley.

Between May 1938 and February 1939 the Company spent £1300 on the Kinwarton scheme (the contractors being G. H. York and Company)[30] and in the Chairman's report for 1939 the works were declared to be complete.[31] Exploitation of the new source was of considerable advantage to the Company, and a benefit to the town. The fact that there was no interruption of the supply during the second war was attributed to the Company's foresight in making use of the Kinwarton source.[32]

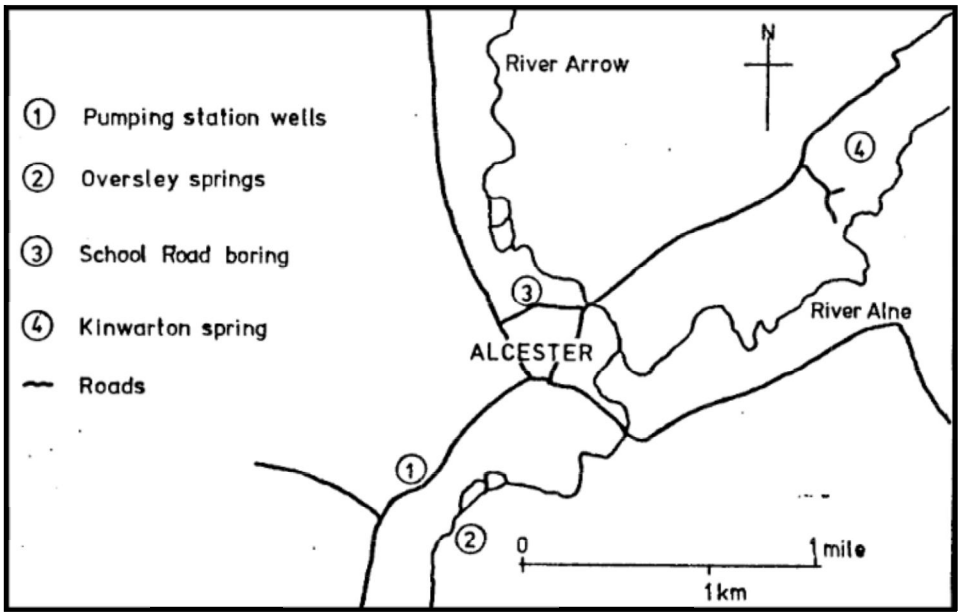


**Figure 4.5 : Water sources used by the company**

The spring at Kinwarton was believed to be a 'fissure in the Keuper Marl' and yielded around 72,000 gallons per day.[33] It was tapped in a simple way by sinking a circular concrete chamber over it; the water from the spring entered the chamber through a number of holes in the side, and through a bed of gravel laid on the floor. From here it gravitated to a concrete holding tank of 2,200 gallons capacity, and was then pumped directly into the Company's existing mains by an electrically driven force pump (see Chapter 3 for a description of the pumping gear). Since the Kinwarton pumphouse lay slightly lower than the reservoir on Grunt Hill, the latter provided the effective head of the system. To judge from the electric time-switch which still exists (in 1979) in the pumphouse, the Kinwarton pump operated only during the night; its effect would have been to replenish the reservoir through the distribution mains. Arrangements were made to chlorinate the water from Kinwarton (as was also done at Arrow); the chlorination procedure will be described in detail later in this chapter.

As soon as the Kinwarton spring came into use, renting of the School Road spring was abandoned and the Company depended upon the Oversley springs, the Arrow well and borehole, and the Kinwarton spring for the remainder of its existence.

This brief outline of the development of the Company's water sources has shown that for a considerable period the demand for water from the consumers exceeded the supply available. However the Company appears to have kept no record of the volume of water supplied daily (or at least no such records have survived) and the average daily consumption can only be estimated with the aid of the few figures which are available. In 1915 the average daily quantity of water supplied was said to be 31,000 gallons, and that a further 35,000 gallons could be obtained,[34]

This figure is repeated without comment by Richardson; it can only have been the Company's own estimate as supplied for *The Return as to Water Undertakings in England and Wales,* If true, it suggests that the Company's sources were under-exploited, for only two years after the publication of the *Return,* in 1917, the Company was again short of water. Possibly 31,000 gallons was the daily quantity supplied on average, and the extra 35,000 gallons was the Company's customary optimistic guess.

Figures given in the same report of 1915 enable an estimate of the volume of water supplied per person to be estimated as shown below. The figures are presented in table 4.1:

**Table 4. 1: Details of Water Supplied In the Parishes of Alcester and Arrow in 1914**

| Parish | Population in 1911 | Total of houses | Houses supplied by AWWCo. |
|---|---|---|---|
| Alcester | 2168 | 574 | 385 |
| Arrow | 317 | 79 | 3 |

(From *The Return As To Water Undertakings In England & Wales*, Part II, page 535)

If it is assumed that the number of persons supplied in each parish was proportional to the number of houses connected then :

| | | |
|---|---|---|
| Consumers in Alcester parish | = | 2168 x 385/574 |
| | = | 1454 |
| Consumers in Arrow parish | = | 317 x 3/79 |
| | = | 12 |
| Whence total consumers | = | 1476 |
| So that total quantity supplied per person per day | | |
| | = | 31000/1476 |
| | = | **21 gallons** |

This can only be a very rough estimate, since it fails to take account of the industrial users such us the brewery and the steam laundry. Probably the real figure is somewhat less than the estimate made here. By modern standards the quantity supplied per person is very small, but it was greater than the thirteen gallons per head which Pritchard had allowed in his original scheme (see note 37 to Chapter 2).

Of the distribution system there is little to say. The only plan of the distribution mains which it has been possible to trace is that given in 4.1. The mains were said in 1885 to have been extended to various points of the town so that the ‘whole town was connected apart from about one

dozen houses',[36] but there is some doubt about these figures and they are discussed in more detail in Chapter 5. Nonetheless it is clear that the distribution mains were extended well beyond the points indicated in figure 4.1 quite soon after the Company started to supply water, although, as mentioned above, the mains were not extended to Arrow village until 1912.

The pressure in the delivery mains was provided by the head of water from the reservoir, being about 50 feet above the town, and the rising main from the pumping station also served to deliver the water from the reservoir to the distribution main under the Evesham-Alcester Road. This carried the water into the town, and various branches carried it to the streets and thus to the consumers.

Before turning to the subject of water treatment, some consideration must be given to the quality of the water as supplied to the consumers. The Company employed no analyst, carried out no quality control on a regular basis, and left no records of the analyses which were carried out, so recourse must be made to the few reports which do exist. The report of the Company's supply in *The Return as to Water Undertakings in England and Wales*, describes the quality as 'Good. Hard and with no action on lead.'[37] Since this is almost certainly the Company's own description it can scarcely be regarded as objective. In 1879, to give the other side of the picture, the water had been described as '. . . discoloured, some times white and sometimes green, with living things in it - at any rate discoloured as the Directors admitted' by the Reverend Moses Philpin, a bitter opponent of water schemes in general; possibly his description is a little exaggerated.[38]

Nonetheless it is clear that the water supply did give cause for concern from time to time. In 1914 for example (about the time that the data for *The Return As to Water Undertakings* were being compiled), the Rural District Council was informed by the Medical Officer of Health of the results of an investigation of the Alcester supply carried out by the County Analyst. Samples had been taken from 'the tank in the field' (presumably the catchment tank at Oversley) and 'the well' (probably the borehole). Neither was to be regarded as of a high purity. This was corroborated by a bacteriological examination; there was evidence evidence of organic contamination of both sources and both were extremely hard.[39]

Confronted with this report, the Company had its own samples analysed by Southall Bros. and Barclay of Birmingham, who reported favourably upon them.[40] This did not satisfy the Medical Officer of Health, who complained that the Company's analysts had carried out no bacteriological examination. So this was done on further samples and they were reported to be 'of good potable quality suitable in every way for drinking purposes.' At this the Rural District Council resolved to take no further action.[41] The Medical Officer of Health was sufficiently disturbed to recommend bacteriological examination of the water in 1920;[42] he gave an estimate of the cost of such an analysis as £5 to £7 per sample. Perhaps because of this no further action was taken.[43]

Finally a report was made on the Alcester Waterworks Company's supplies in 1946 in connection with new schemes under preparation for the water supply of the district. The engineers[44] commissioned by the Rural District Council to report on the situation described the Company's supply as ' .... hard with 100 parts per 100,000' but made no comment on the bacteriolog-

ical condition of the water.[45]

In summary it would perhaps be fair to say that the Company's supply was normally reasonable in quality, but rather variable. As to treatment, for the greater part of its existence the Company did not do any, not even filtration. Being drawn from springs and a borehole of course, the water should have been largely free from suspended matter, and the well/holding tank would have acted partly as settling tank.

The first definite evidence of water treatment is not to be found until 1939, when the Company purchased chloride of lime from the local pharmacist at a cost of 7 shillings (35p).[46] Presumably this was to be added to the water in the reservoir as a crude form of chlorination. In 1940 the Company started to buy Chloros (the Imperial Chemical Industries trade name for concentrated sodium hypochlorite solution),[47] and in the same year £164-10s was spent on a chlorination plant at the Arrow pumping station.[48] Since no purchase of liquid chlorine is recorded, it must be presumed that the plant worked by addition of Chloros to produce the required free chlorine concentration. In 1942 the Company spent a further £107 on a 'hypochlorimeter', presumably a device for the continuous recording of the chlorine concentration of the water.[49] The sums spent on Chloros from 1943 to 1947 are shown below.

**Table 4.2: Expenditure on Chloros, 1943-47** (from the Company's ledgers)

| Year | Expenditure (In £) |
|---|---|
| 1943 | 4.56 |
| 1944 | 10.36 |
| 1945 | 4.91 |
| 1946 | 18.35 |
| 1947 | 15.15 |

The chlorination plant seems to have been rather uncertain in its operation, for in 1946 the Rural District Council, as a result of an analyst's report, warned the Company that its water supply was insufficiently chlorinated.[50] The latter gave an assurance that proper chlorination would be undertaken in the future and no doubt this explains the increased expenditure on Chloros in 1946 and 1947.

Finally an attempt must be made to set the Alcester Waterworks Company's policy on water treatment in a national context to see whether it might be regarded as backward in these respects. The type of treatment used would be partly determined by the source of the supply of course, some sources needing more treatment than others. If filtration is considered as the most basic form of treatment it is evident that most of the country's waterworks (at least at the time of *The Return as to Water Undertakings*) did not do even this. Table 4.3 below, which is based on information in the pre-amble to *The Return as to Water Undertakings* illustrates the point.

In other words, more than 80% of water suppliers in England and Wales did not filter the water which they supplied to the consumers, so the Alcester Waterworks Company was by no means backward in this respect. Most of these suppliers which did not use filtration were small

undertakings no doubt, but a number of large and important ones did not do so either, and these included Manchester, Whitehaven, Plymouth, and Swansea.[51]

**Table 4.3: The Incidence of Filtration Among Water Suppliers, 1915**

| Type of Supplier | Total | Using Filtration | % |
|---|---|---|---|
| Local Government Authorities | 786 | 200 | 25.4 |
| Joint Water Authorities | 35 | 14 | 40.0 |
| Companies | 284 | 88 | 30.0 |
| Private Proprietors | 1055 | 116 | 11.0 |
| Totals | 2160 | 418 | 19.0 |

With regard to chlorination, in 1915 the practice seems to have been almost unknown; at least *The Return as to Water Undertakings* makes no mention of it being carried out on a regular basis, not even by the Metropolitan Water Board. By 1922 however chlorination by various methods was described in a book on waterworks technology;[52] one of these was the method of addition of sodium hypochlorite solution, or 'Chloros', which was ultimately used by the Alcester Waterworks Company. This did not come about until 1941, as a result of pressure from the Ministry of Health. This pressure resulted from concern about a typhoid epidemic in Croydon in the late 1930's which was shown to have resulted from infection of the water supply, and is discussed in Chapter 6.

A piece of visible evidence relevant to this point may still be seen in the Kinwarton pumphouse today. The pumphouse was built in 1938, and the Company clearly had no thought of installing chlorination apparatus, for the feed tube which eventually connected the Chloros reservoir with the inlet side of the pump is still in position and it crosses the floor of the pumphouse in a rough channel cut with a hammer and chisel in the concrete, so was clearly added later as an afterthought.

**Table 4.4: Types of Water Sources Exploited by Waterworks Companies in 1915** From *The Return as to Water Undertakings*

| | Company Type | | | | | |
|---|---|---|---|---|---|---|
| | 1 | | 2 | | 3 | |
| Source Type | No. | % | No. | % | No. | % |
| Well | 71 | 47 | 26 | 54 | 19 | 23 |
| Artesian well | 6 | 4 | 3 | 6 | 1 | 1 |
| Spring | 44 | 29 | 15 | 31 | 52 | 62 |
| Borehole | 39 | 26 | 9 | 19 | 4 | 5 |
| Gathering Ground | 9 | 6 | 4 | 8 | 2 | 2 |
| River | 29 | 19 | 3 | 6 | 1 | 1 |
| Bulk purchase | 5 | 3 | 1 | 2 | 0 | - |
| Adit | 1 | 1 | 1 | 2 | 0 | - |

| | Company Type | | | | | |
|---|---|---|---|---|---|---|
| | 1 | | 2 | | 3 | |
| Minewater | 1 | 1 | 0 | - | 0 | - |
| Lake | 1 | 1 | 0 | - | 1 | 1 |
| Totals of companies | 152 | | 48 | | 84 | |

**Notes**

(a ) Companies in category 1 operated under special Acts of Purl Parliament, those in category 2 under Provisional Water Orders, and those in category 3 were without statutory powers.

(b) The percentages have been rounded off to the nearest percentage point. They may not sum to 100 because a number of companies used more than one kind of source.

(c) An adit is a eloping tunnel driven into the rock so that water will drain outwards.

The treatment which was used by a water supplier depended on the sources of supply, the general principle being that surface waters and rivers were suspect, whereas underground sources were not. Since small suppliers tended to use underground sources, especially springs and wells, it might be expected that they would make less use of filtration and other treatments. Table 4.4 above shows the types of water sources exploited by waterworks companies as given in *The Return as to Water Undertakings*. The companies have been divided into three categories according to the powers under which they operated.

The results in the table show that springs, wells and boreholes were the commonest sources to be exploited by the companies with statutory powers; springs were more frequently exploited by the companies without powers, presumably because they could be harnessed with the minimum of capital expenditure, and the undertakings in this class tended to be very small scale concerns. In fact 62% of such companies, and 52% of those operating under Provisional Orders used springs for at least part of their supply. *The Return as to Water Undertakings* shows that of the 96 companies which filtered their supplies, thirty drew their supplies from rivers or streams. These were the kinds of sources likely to be polluted, so filtration would be more necessary for them. Since the Alcester Waterworks Company drew its supply from springs, a well and a borehole, the fact that it carried out no filtration was in no way anomalous.

Another aspect of water technology which may be studied through the data in the *The Return as to Water Undertakings*, is water analysis. The Alcester Waterworks Company carried out no systematic analysis until the 1940's when samples were regularly examined by bacteriological methods around the time when chlorination was being introduced. Before this analyses were curried out us the need arose, usually as a response to some complaint from the Rural District Council. The question arises as to whether the Alcester Company was unusual in this respect in failing to carry out routine testing of its supplies. *The Return as to Water Undertakings* provides information on this point in that when asked to state the quality of their supplies, some companies furnished details of the kind of analysis employed, together with notes as to its frequency. If the assumption is made that those companies which gave no such information carried out no analysis

since they would have wished to be represented in the most favourable possible light and would have reported the analysis if they did any, table 4.5 has been prepared showing, the kind of water testing carried out by the three kinds of company listed in *The Return as to Water Undertakings.*

**Table 4.5: The Analysis of Water Supplies by Waterworks Companies in 1915** (From *The Return as to Water Undertakings*)

| | **Company Type** | | | | | |
|---|---|---|---|---|---|---|
| | **1** | | **2** | | **3** | |
| **Analysis & Frequency** | No. | % | No. | % | No. | % |
| None | 27 | 18 | 23 | 48 | 47 | 56 |
| Occasional examination (type unspecified) | 20 | 13 | 4 | 8 | 11 | 13 |
| Chemical; | | | | | | |
| Occasional | 22 | 14 | 7 | 15 | 10 | 12 |
| Periodic | 13 | 9 | 2 | 4 | 0 | - |
| Annual | 10 | 7 | 6 | 12 | 2 | 2 |
| Half-yearly | 5 | 3 | 2 | 4 | 0 | - |
| Quarterly | 18 | 12 | 1 | 2 | 1 | 1 |
| Frequently | 2 | 1 | 0 | - | 1 | 1 |
| Bi-monthly | 2 | 1 | 0 | - | 0 | - |
| Monthly | 18 | 12 | 0 | - | 0 | - |
| Daily | 1 | 1 | 0 | - | 0 | - |
| **Totals (chemical analysis)** | **91** | **60** | **18** | **38** | **13** | **16** |
| **Bacteriological analysis** | | | | | | |
| Occasional | 14 | 9 | 2 | 4 | 0 | - |
| Periodic | 15 | 10 | 3 | 6 | 0 | - |
| Annual | 3 | 2 | 2 | 4 | 0 | - |
| Half-yearly | 7 | 5 | 1 | 2 | 0 | - |
| Quarterly | 18 | 12 | 0 | - | 0 | - |
| Frequently | 1 | 1 | 0 | - | 0 | - |
| Monthly | 8 | 5 | 0 | - | 0 | - |
| Daily | 1 | 1 | 0 | - | 0 | - |
| Totals (bacteriological analysis) | 70 | 46 | 8 | 17 | 0 | - |

**Notes:**

(a) The descriptions of the frequency of analysis are exactly as given in *The Return as to Water Undertakings.*

(b) All percentages have been rounded off as for previous tables.

Table 4.5 shows that the three types of company differed considerably in their practice of water

analysis. Very nearly one half of all the companies under Provisional Orders carried out no analysis at all, and neither did 56% of those without statutory powers. The Alcester Waterworks Company belonged to the largest single category of the companies operating under Provisional Orders, namely those which carried out no routine analysis at all. These made up 48% of such companies. The typically larger concerns which operated under Acts of Parliament were more assiduous in their water testing; only eighteen of these carried out no analysis at all, and 60% did at least some chemical analysis.

Bacteriological analysis, the most important from the public health view point, was overwhelmingly a province of the larger companies working under Acts of Parliament; 46% of these carried out at least some bacteriological testing, whereas only 17% of companies with Provisional Orders, and none of those without powers did so.

Only one company carried out daily chemical and bacteriological testing. This was the York Waterworks Company which supplied three million gallons daily, drawing its water from the River Ouse. In view of the nature of the source such (by the standards of the time) intensive testing was very wise.

So the Alcester Waterworks Company continued for over sixty years without any treatment of its supplies at all, and introduced only a simple form of chlorination in the last few years of its existence. It carried out no systematic analysis either but in these respects it must be considered to be representative of many other small water suppliers in Britain who likewise did neither of these. In Alcester's case at least, probably the nature of the supply and the scale of the operation made anything more elaborate a waste of money.

In any event there were no large scale epidemics of waterborne disease after most of the households in the town were connected to the distribution mains.

## Notes and References to Chapter 4

1. Paisley's water was filtered from 1804 onwards; Smith N., *Man and Water: A History of Hvdrotechnology* , London 1974, page 104.
2. For a good account of modern water treatment processes see: Overman, M. , *Water : Solutions to a Problem of Supply and Demand*, Open University Press, Milton Keynes 1968 (revised 1976) pages 153-175.
3. AC, 10 February 1912; Report of the Annual General Meeting of the Waterworks Company.
4. *Redditch Indicator*, 6 February 1886; Report of Annual General Meeting of the Waterworks Company.
5. *The Return as to Water Undertakings in England and Wales*, H.M.S.O.., 1915, page 175.
6. Richardson, L., *Spring and Wells of Warwickshire*, Memoirs of the Geological Survey of Great Britain, H.M.S.O., 1928.
7. WRO, CR 51/92. Minute of meeting of Alcester Rural Sanitary Authority, 29 October 1890.
8. AC, 7 March 1891. Report of the meeting of Alcester Board of Guardians
9. WRO, CR 51/92. Minute of meeting of Alcester Rural Sanitary Authority, 4 February 1891.
10. WRO, CR 1547/1. Minute of meeting of Rural Sanitary Authority 4 July 1894.
11. WRO, CR 1547/2. Minute of meeting of Alcester Rural District Council, 22 July 1896.
14. WRO, CR 1547/2. Minute of Alcester Rural District Council , 28 October 1896.
15. Ibid, 28 July 1897.
16. Ibid, 22 September, 1897 .
17. Ibid, 20 October 1897.

18. Ibid
19. Ibid, 28 February 1909.
20. WRO, CR 1547/3. Minute of meeting of Alcester Rural District Council, 18 July 1900.
21. Ibid, 15 August 1900.
22. Ibid, 7 August 1901.
23. WRO, CR 1547/356 Cash Book of Alcester waterworks Company, entries for 1901 and 1902
24. WRO, CR 1547/8. Minute of meeting of Alcester Rural District Council, 14 February, 1917.
25. WRO, CR 1547/ 9. Minute of meeting of Alcester Rural District Council, 16 November 1921.
26. Ibid, 8 February 1922.
27. WRO, CR 1547/356. Cash Book of Alcester Waterworks Company, entry for 20 December 1935.
28. The circumstances surrounding the sinking of this well are described in Chapter 2, page 57
29. Richardson, L., op.cit. (note 6 above).
30. WRO, CR 1547/356. Cash Book of Alcester Waterworks Company, entries for 1938 and 1939.
31. AC, 11 February 1939. Report of the Annual General Meeting of the Waterworks Company.
32. Redditch Indicator, 7 February 1948. Report of the final Annual General Meeting of the Waterworks Company.
33. The information on the yield of the Kinwarton Spring was kindly provided by the East Worcestershire Waterworks Company.
34. Op.cit. (note 5 above)
35. Op. cit. (Note 6 above).
36. AC, 7 February 1885; Report of Annual General Meeting of the Waterworks Company.
37. Op.cit.. (note 5 above).
38. AC, 27 September, 1879; Report of meeting of Alcester Rural Sanitary Authority.
39. WRO, CR 1547/ 7. Minute of meeting of Alcester Rural District Council, 2 September 1914.
40. Ibid, 30 September 1914.
41. Ibid, 28 October 1914.
42. WRO, CR 1547 9. Minute of meeting of Alcester Rural District Council, 11 February 1920.
43. Ibid, 17 November 1920.
44. The engineers concerned were J. D. and D. M. Watson, M.M. I. C.E. , Westminster .
45. WRO, CR 1547/24, Minute of meeting of Alcester Rural District Council, 7 May 1946.
46. WRO, CR 1547/356. Cash Book of Alcester Waterworks Company, entry for July 1939.
47. Ibid, 1940.
48. Ibid, 23 December 1940.
49. Ibid, entry for 17 August 1912.
50. WRO, CR 1547/25. Minute of meeting of Alcester Rural District Council , 11 September 1946.
51. *Return as to Water Undertakings in England and Wales*, H.M.S.O.., 1915, Preliminary Memoranda, Section 103.
52. Adams, H. C.; Waterworks for Urban and Rural Districts (1st edition), Pitman, London 1922 pages 132,137.

## Chapter 5 : Social Aspects of the Company's Relationship with The Town of Alcester

In previous chapters it has been shown that the Alcester Waterworks Company came into being as a result of public health legislation in the nineteenth century. The purpose of this section is to examine the relationship between the citizens of Alcester and the waterworks company.

Epidemics of diseases such as cholera and typhoid often had a stimulating effect upon public health activity in nineteenth century Britain, both locally and on a national scale. The great Public Health Acts of 1848 and 1875 were themselves a consequence of the devastating outbreaks of cholera which struck the country from 1830 onwards. In small towns the approach of the cholera in 1848 created an interest in public health matters not previously evident; such was the case in Stratford-on-Avon, where a Local Board of Health was formed under the 1848 Act, and plans were laid for comprehensive water supply and sewerage schemes. When the epidemic passed without a single death in the town, the citizens wondered whether they had been wise to act so hastily, and the schemes of sanitary improvement were considerably modified. As a result the town remained without a supply of piped water until 1886, when the Urban Sanitary Authority which had by then assumed responsibility for such matters was pressurised in to acting on the question of water supply.

In the case of Alcester, an epidemic of smallpox in 1875 brought the town under the consideration of the Local Government Board and so involved it in the schemes of sanitary improvement which led ultimately to the foundation of the waterworks company. Owing its birth to one epidemic, the Company was given a powerful stimulus to growth by another. In late 1879 the town was struck by an epidemic of typhoid fever which spread in much the way that the Medical Officer of Health had predicted, by infection of the wells. The Company had been supplying the town since March of the same year, but the number of houses supplied was not large. In February 1880 for example the Chairman's annual report revealed that only 215 houses out of 472 were connected with the mains, a mere 46%.[1] Just before the outbreak of typhoid, in September 1871, things were even worse, with only 154 houses being supplied by the Company out of 472.[2]

The epidemic was in fact a fairly mild one with only eight fatalities in twenty-nine cases, so that it affected directly only 1% of the population of the town, but it raised a vigorous debate in the local newspaper concerning the role of polluted well water in the transmission of the disease. The Chairman of the Company wrote to the newspaper giving details of an analysis of the Company's water by Dr. Voelker, Professor of Chemistry at the Royal Agricultural College in Cirencester; the water was declared to be fit for all purposes and safe to drink.[3] The Chairman went on in his letter to point out that there had been no outbreak of fever where the Company's water was laid on, and the house was connected with sewers.

This was a point likely to encourage acceptance of the water of course and apparently some such inducement was needed, for at a discussion of the town's water supply by the Rural Sanitary Authority in September 1879, there was said to be reluctance in the town to take the Company's water because it had to be paid for.[4] Presumably those who did not take the piped sup-

ply made do with the well water as they had done for centuries past.

Under the Water Supply Act of 1878 the Rural Sanitary Authority had powers to close wells known to be polluted, and enforce the supply of wholesome water to the dwellings concerned. Some time before the epidemic in fact the Inspector of Nuisances had listed places where the well water was believed to be unsuitable for drinking, and notices were to be served under the Act, ordering the owners of property to supply tenants with a suitable supply of water.

The Rural Sanitary Authority did eventually use its powers of well closure, and reported this to the Local Government Board on 15th September.[5] The enforced closure of wells brought a spate of indignant letters written to the local newspaper but must have been a source of satisfaction to the Directors of the Waterworks Company whose pipes were the only source of a suitable alternative water supply. However, the epidemic soon ended; by the 30th September the Medical Officer of Health was able to report that there had been no further outbreaks.[6] The Company did not lose an opportunity to gain some favourable publicity, for the Chairman reported in a letter to *The Alcester Chronicle* that 'in no single instance where the Company's water is used has a case of typhoid appeared'.[7]

It is important not to exaggerate the importance of the 1879 epidemic on the fortunes of the Alcester Waterworks Company but it does seem that the increase of sixty-one in the number of houses connected between September 1879 and February 1880 is attributable to the outbreak of typhoid fever. The episode also sheds some light upon the attitudes of the citizens, or more accurately the property owners, to the piped water supply. They were unwilling in many cases to install the supply in their properties unless compelled to do so. Most of the properties in the town were rented, and the attitude of the proprietors was a brake upon sanitary improvement in the town. What the inhabitants of the poorer houses thought we have no way of telling for they wrote no letters to The Alcester Chronicle, nor did they raise matters with the Rural Sanitary Authority.

Although the epidemic had clearly indicated the connection between polluted wells and typhoid fever, since in every case those infected were shown to have used polluted subsoil wells, as soon as the fever departed, the pressure for well closure slackened; despite a few cases of typhoid early in 1880 the Rural Sanitary Authority closed no wells that year. Possibly this explains the enquiry from the Local Government Board of October 1880 asking what the Authority had done to 'remedy the dangerous state of well water in Alcester.'

At this stage the water mains had not been extended to the whole of the town; this was not achieved until September 1881 and even then a few small areas remained without the possibility of connection. Even in the areas where the mains were available, 150 houses were still not taking the water.[9] The Directors of the Company were clearly aware of this unexploited source of revenue, for a deputation was sent to the Rural Sanitary Authority, asking for assistance in 'getting the people to take the water.'[10] The Chairman of the Sanitary Authority pointed out that that body had 'no power to interfere where the water was good but that otherwise steps would be taken to compel use of the piped water ...' Some pressure was probably being exerted on the Rural Sanitary Authority by the Local Government Board which had 'some time since enquired how many houses were

supplied by the Waterworks', and urged the necessity of adopting it.

The case put forward by the Company's representatives to the Rural Sanitary Authority sheds some light upon the attitudes of the citizens to the piped water supply. It was stated that '- they met with a great deal of dissatisfaction in collecting the water rate. One person objected to pay because his neighbour did not'. In other words, those with the piped water were not altogether convinced that it was an advantage worth paying for, even after the typhoid epidemic of 1879. Possibly the memories of the epidemic faded as time passed by.

September 1881 marked the beginning of a new campaign against the polluted wells which was to last until 1883, The effect of this was to increase the number of houses connected to the Company's mains. The Rural Sanitary Authority's meetings were attended by some discussion about this general campaign of well closure, opposition to it being provided by the Baptist minister for the town, the Reverend Moses Philpin. His main point was that every well in the town should be analysed, and closure enforced only for those which were found to be polluted. The Inspector of Nuisances on the other hand had been directed to list the wells which he had reason to believe were suspect so that action could be taken against those first.[12] Mr. Philpin's concern for fairness (as he put it) was not altogether disinterested. He was the owner of some poor property in the town, the tenants of which used polluted wells as their source of supply. Indeed a well on Mr. Philpin's property had been closed by order of a Magistrate in 1876.

The suggestion of having every well in the town tested was rejected when it was pointed out that this would cost about £76. The Sanitary Authority finally decided to invite the owners of the properties with suspect wells to take the piped water, and if they declined, to have the water analysed. The owners did indeed decline, so certain samples were taken from the wells of houses in Church Street and High Street near the centre of the town.[13] The wells were found to be polluted and the owners of the properties were ordered to install piped water supplies; by the end of November 1881 most had done so, or had given instructions for it to be done.[14] Two owners remained obdurate however and the Inspector of Nuisances was ordered to take action under the Public Health Act of 1875 to have the wells closed by Magistrate's order.[15]

The process continued in 1882; the pattern of events was as follows. The Inspector of Nuisances would make a list of dwellings with a suspect supply and would report to the Rural Sanitary Authority. Samples would be taken from the wells in question and if found unfit for drinking, the owners would be ordered to close the wells and provide a wholesome supply. In most cases the owners complied after some delay, and only rarely was it necessary to obtain a Magistrate's order.

By March of 1883 it was reported that fifty-five houses were still not connected even where the mains were available, and a number of these were supplied after threats of well closure. The campaign effectively ended in August 1883. Even after this a number of houses were still dependent upon wells and some wells remained in use even where the piped water was supplied. Indeed a number of houses in the town remained without piped water until the very end of the Company's existence.[17]

The fact that polluted wells were not always closed was a source of public health danger.

An example way be quoted to illustrate this point. The landlady of the Red Horse Inn installed piped water under threat of well closure in August 1883, but asked that the well should remain open despite a closure order being in force so that it could be used for '..... horses, washing of carriages and cleansing'. The Rural Sanitary Authority decided not to oppose this application as long as the well-water was not used for human consumption.[18] The danger was of course that this restriction was not easy to enforce, especially when, as was not infrequent in the 1890's, the Company's supply was deficient. Two cases of typhoid fever were traced to a polluted well in the yard of the Globe Hotel in September 1891, for example, and this well was ordered to be closed by the Sanitary Authority; pungent comments appear in the minutes about the failure of the water supply which left people '.... without drinking water unless it was obtained from old and polluted wells.'[19]

By 1885 the Chairman of the Waterworks Company was able to tell the shareholders that practically every house in the town was connected to the mains, 'only a dozen or so being left out.'[20] It has been shown above that typhoid fever played its part in the establishment of piped water in Alcester by stimulating the Sanitary Authority to take a strong line on polluted wells. The Company benefitted as a consequence and this was not to everyone's liking. At least one letter was published in The Alcester Chronicle contending that people preferred to use the wells even when supplied with the Company's water and accusing the Company's Directors of ' .. attempting to line their own pockets.'[21]

Certainly the Company did benefit from the sanitary improvements brought about by the Rural Sanitary Authority; the question to which we now must turn, is the extent to which the citizens benefitted. Contemporary evidence suggests that they did. In his report for 1882, the Medical Officer of Health for the combined districts, G. H. Fosbroke, drew attention to ' . . the present healthy state of Alcester where a wholesome supply has for a few years been accessible.'[22] Certainly there was no major typhoid epidemic after the 1879 outbreak. There were a few cases in 1880 and 1881, but these could scarcely be considered in the same light. The few cases which were reported after this date were usually traced to infection sources outside the district. In 1882 for example, Evesham, less than ten miles away, experienced a major outbreak of typhoid which was traced to the use of polluted well water at the annual regatta.[23] This produced forty-eight cases in Evesham Borough and twenty-one in the Rural District; there were eight fatalities in all. Alcester remained free of the disease save for one case in the town, and that was believed to have been contracted at the regatta in Evesham. The introduction of piped water had deprived the disease of a rapid route from cesspit to well whereby it might spread through the town.

The situation in Evesham is interesting in itself; the town was apparently a source of typhoid fever. The inhabitants depended upon shallow sub-soil wells which were easily polluted, and there was no effective sewage system. Work started on the Urban District Council's waterworks in 1883 and supply commenced in 1885; the sewage scheme came into operation at about the same time. As in Alcester's case there was some reluctance to take the water at first but by 1886 the Medical Officer of Health was able to state that 'Typhoid fever has been driven out of Evesham. The substitution of the waterworks for polluted wells has deprived typhoid of its foothold in the

town.' [24]

It is not easy to find figures to support the opinions of the Medical Officer of Health with regard to the benefit of piped water to the town of Alcester. Figures are not available for the period before 1874 in detail and in general, the data after that date refers to the Alcester Registration Sub-District, which was only a part of the Alcester Rural District and Alcester town formed only a part of the Alcester sub-district. Nonetheless the annual reports of the Medical Officer of Health contained comments on the incidence of disease which enable one to make some estimate of the incidence typhoid fever in the town. Table 5.1 presents the results of this and while the results cannot be described as striking evidence for improvement, it does seem that after 1883 when most of the houses in the town were connected with the Company 's mains, nearly all the cases of typhoid were attributable to polluted well water, or were contracted outside the town. Had the polluted wells all been closed things might have been very much better; without the piped water the situation would probably have been very much worse.

**Table 5.1: The Incidence of Typhoid Fever in Alcester, 1874-89**

| Year | Cases | Fatalities | Source of Infection (where known) |
|---|---|---|---|
| 1874 | 1 | 1 | |
| 1875 | - | - | No data available |
| 1876 | - | - | No data available |
| 1877 | 1 | 1 | |
| 1878 | 3 | 0 | |
| 1879 | 29 | 8 | |
| 1880 | 5 | 3 | |
| 1881 | 1 | 1 | Polluted well water |
| 1882 | 0 | 0 | |
| 1883 | 1 | 0 | |
| 1884 | 1 | 1 | |
| 1885 | 3 | 1 | Incurred away from Alcester |
| 1886 | 1 | 0 | Contracted away from Alcester |
| 1887 | 2 | 1 | |
| 1888 | 3 | 0 | Not contracted in the town |
| 1889 | 3 | 0 | Polluted well in the town |

(Based on the annual reports of the Medical Officer of Health)

Another way of looking at the problem is to compare the situation in other nearby towns without piped water. Stratford-on-Avon and Evesham are suitable cases for comparison; both were about four times larger than Alcester in population. Stratford had piped water after 1886 and Evesham after 1885. Table 5.2 below compares the incidence of typhoid per million of population in the three towns.

**Table 5.2: Incidence of Typhoid Per Million of Population for Alcester, Evesham and Stratford on Avon, 1883-1889**

| Year | Alcester | Evesham | Stratford |
|---|---|---|---|
| 1883 | 0.423 | 1.96 | 0 |
| 1884 | 0.423 | 2.15 | 0.62 |
| 1885 | 0 | 0 | 0.248 |
| 1886 | 0 | 0 | 0 |
| 1887 | 0.846 | 0.978 | 0.496 |
| 1888 | 0 | 1.17 | 0 |
| 1889 | 1.23 | 1.37 | 0 |
| Average | 0.423 | 1.09 | 0.194 |

(Based on the annual reports of the medical Officer of Health)

If the results are compared for the years 1883 to 1889, it will be seen that the incidence of typhoid for Alcester was intermediate between that for Stratford and the rate for Evesham. The low incidence of typhoid fever in Stratford must be partly attributed to the sewage system installed in the 1850's, and living conditions in the town were probably better than those in Alcester, so that the latter does not compare too unfavourably. In fact if we compare the years when Alcester had piped water and Stratford did not, Alcester comes off slightly better. From 1883 to 1886 when this was the situation the average incidence is 0.21 for Alcester and 0.22 for Stratford. Both towns seem to have a consistently better record than Evesham, both before and after that town had piped water.

Finally some attention must be given to the zymotic death rates in the combined sanitary districts. The three rural and two urban districts which comprised the area shared the same Medical Officer of Health, and the comments in his annual reports provide valuable material. It was given as his opinion that the zymotic death rate was ‘an accurate test of sanitary administation.’[25] The diseases classed us zymotic were smallpox, scarlet fever, typhoid fever and diphtheria. While only one of these, typhoid, was directly related to water supply, the zymotic death rate was taken an an indicator of general sanitary standards.

**Table 5.3: Variation in Zymotic Death Rate For the Alcester Rural Sanitary District, 1876-89**

| **Year** | **ZDR** | **Year** | **ZDR** | **Year** | **ZDR** |
|---|---|---|---|---|---|
| 1875 | 3.4 | 1880 | 1.7 | 1885 | 1.4 |
| 1876 | 1.8 | 1881 | 0.8 | 1886 | 1.1 |
| 1877 | 1.7 | 1882 | 1.4 | 1887 | 0.6 |
| 1878 | 4.0 | 1883 | 0.7 | 1888 | 0.2 |
| 1879 | 2.9 | 1884 | 1.2 | 1889 | 1.2 |

(Based on the annual reports of the Medical officer of Health)

The average for the years before 1880 is 2.76 and for the years after is 1.09. This applies to the

whole of the sanitary area, not the town of Alcester alone and cannot all be attributed to the advent of piped water, but it does suggest a general improvement in living conditions and sanitary practice over this period.

Table 5.4 compares the variation in zymotic death rates for each of the five districts in the combined district. Figures for the two urban districts are not available before 1883.

**Table 5.4: Zymotic Death Rates For the Combined Sanitary Districts, 1875-1889**

| Year | Stratford Rural | Alcester Rural | Evesham Rural | Stratford Urban | Evesham Urban |
|---|---|---|---|---|---|
| 1875 | 0.5 | 3.4 | 1·8 | not available | not available |
| 1876 | 1.5 | 1.8 | 0·5 | not available | not available |
| 1877 | 1.1 | 1.7 | 1·9 | not available | not available |
| 1878 | 0.7 | 4.0 | 2·1 | not available | not available |
| 1879 | 1.9 | 2.9 | 1·5 | not available | not available |
| 1880 | 0.5 | 1.7 | 0.3 | not available | not available |
| 1881 | 0.6 | 0.8 | 0·9 | not available | not available |
| 1882 | 0·8 | 1·4 | 1·4 | not available | not available |
| 1883 | 0·4 | 0·7 | 0·5 | 0.3 | 1.5 |
| 1884 | 1·3 | 1·2 | 0·2 | 2.1 | 1.5 |
| 1885 | 0·4 | 1·4 | 1·0 | 0.9 | 0 |
| 1886 | 0.6 | 1.1 | 0.8 | 0.1 | 2.6 |
| 1887 | 0.3 | 0.6 | 0.5 | 0.9 | 3.0 |
| 1888 | 0.7 | 0.2 | 0.4 | 0.8 | 0.7 |
| 1889 | 0.7 | 1.2 | 0.5 | 0.4 | 2.6 |

(Figures give the death rate from zymotic disease per thousand of population)

Once again the Evesham Urban District shows up particularly badly, and Stratford rather well. Alcester has the highest average zymotic death rate of the rural districts, but the comparison is not a fair one because the Alcester Rural District had a higher proportion of urban and manufacturing areas than the other two, which were almost entirely agricultural. In comparison with the purely urban districts Alcester does rather better. Such improvement as there was in all five areas must be attributed to the general improvement in sanitary matters which resulted from the 1875 Public Health Act and the activities of the Medical Officer of Health, but the provision of piped water, first in Alcester, then in the other two towns must have played its part.

An epidemic again proved significant in the course of sanitary reform in Alcester in 1877 with regard to the provision of sewage disposal. It was shown in Chapter 2 that the Rural Sanitary Authority originally planned to drain the town and provide piped water, and the engineer, Edward Pritchard, was instructed to prepare plans to this effect. As a result of public outcry, the water supply was eventually given over to the Alcester Waterworks Company, and the sewage scheme was shelved, so it was planned to operate a system of scavengering in the town to dispose of solid

wastes.[26]

It was a common feature of schemes of sanitary improvement in the nineteenth century to have the sewage and water supply attended to simultaneously, or at least to require plans for both. Booker, describing the situation in Essex in this period, suggests that the two matters were closely intertwined, and that any distinction between them would be purely arbitrary.[27] However it was not uncommon for one or other of the two schemes to be abandoned when the full cost became known. Thus in Stratford-on-Avon the water supply plans were abandoned and the sewage scheme proceeded with, whereas in Alcester the opposite was the original intention of the Rural Sanitary Authority.[28]

In Alcester's case however, events took a dramatic turn in 1877 when a diphtheria outbreak produced twenty-eight cases and ten fatalities in December. Under pressure from the Marquess of Hertford, always an influential member of the Rural Sanitary Authority, that body resolved to proceed with Pritchard's plans for draining the town.[29] The plans had been proposed in 1875 and shelved in 1876, but by May 1879, two months after the inauguration of the water supply, the town's system of sewers was complete and in operation.[30]

All in all it must be concluded that the Alcester Waterworks Company served the town quite well with regard to public health matters. This service had to be paid for however, and it is to this aspect, that is the payment for the water, that attention must be turned. It is of interest to know what sort of sum of money a householder in Alcester might pay for the water, and how this sum changed over the years.

Like many other water companies, the Alcester concern levied a water rent on the rateable value of the property, if it were a domestic residence. This was paid by the occupier except for the smallest cottages, the owners of which paid an 'owners composition' which was payable whether the property was occupied or not. No doubt the owners collected the payment from the tenants along with the house rent in these cases. Industrial and other similar consumers such as hotels, schools and the like paid a quarterly sum by negotiation. In addition to the water rent, domestic (and other) consumers paid a fixed sum per quarter for a fixed bath and for each water closet (the first being free). The charge for the fixed bath was made in 1904 for the first time and was set at 2/6d (12.5p ). Presumably fixed baths were not sufficiently numerous before this time to make the business worthwhile. In 1904 the charge yielded £5 per annum, so that there must have been ten fixed baths in Alcester at this time. The Company's water rent books have not survived for the period before 1913, or after 1936, but the records which do remain, enable an informative analysis to be made. The scale of charges set in 1878 remained in force until 1904 when an increase took place which played some part in the Company's change of fortune. The charges were increased again in 1920 as a result of the wartime inflation. Presumably there was at least one later increase, but if so it comes beyond the period covered by the Company's Ledgers.

In order to study the payments made by the consumers it is necessary to see how the payments were distributed. Table 5.5 shows the distribution of domestic payments for the quarter ended September 1913, taken from the Company's water rent book, with the values converted into

decimal units.

**Table 5.5: Distribution of water Rent Payments in 1913, 1924 and 1934**

| 1913 | | | 1924 | | | 1934 | | |
|---|---|---|---|---|---|---|---|---|
| Quarterly Payment | No. | % | Quarterly Payment | No. | % | Quarterly Payment | No. | % |
| 0-15p | 214 | 58 | 0-30p | 25 | 5 | 0-30p | 9 | 2 |
| 16-30p | 72 | 20 | 31-60 | 233 | 51 | 31-60 | 241 | 47 |
| 31-45p | 50 | 14 | 61-90 | 78 | 17 | 61-90 | 16 | 23 |
| 46-60 | 15 | 4 | 91-120 | 47 | 10 | 91-120 | 62 | 12 |
| 61-75 | 6 | 2 | 121-150 | 32 | 7 | 121-150 | 39 | 8 |
| 76-90 | 4 | 1 | 151-80 | 21 | 5 | 151-80 | 25 | 5 |
| 91-105 | 3 | 1 | 181-210 | 11 | 2 | 181-210 | 12 | 3 |
| 106-120 | 1 | .27 | 211-240 | 5 | 1 | 211-240 | 5 | 1 |
| 121-135 | 0 | 0 | 241-270 | 3 | 1 | 241-270 | 2 | 0.4 |
| 136-150 | 0 | 0 | 271-300 | 1 | 0.22 | 271-300 | 2 | 0.4 |
| 151-165 | 1 | 0.27 | | | | | | |

(From The Company's Water Rent Books)

The table shows that in 1913, 78% of households taking the water in the town paid £1.20 (£1. 4s) or less per year and the largest sum paid was only £6.60 (£S.). These do not appear to be large sums and one must suppose that the Company's water was relatively cheap in the period before the First World War. Rather puzzling is the fact that the rent books show only 367 payments being made at this time whereas the records of the Rural Sanitary Authority suggest that around 430 houses were connected as early as 1883. *The Return as to Water Undertakings* suggests that the number of houses supplied in Alcester parish was 385, in fairly good agreement with the water rent book.[32] Possibly some houses had been demolished, or disconnected from the mains between 1883 and 1913.

The Company's revenue could have been increased in three ways: the scale of charges could have been raised, the rateable value of the town could have been increased or more houses could have been built. In fact all three occurred. By 1920 the rent for a property rated at £11 had risen to 45p (9 shillings), but the maximum payment was for premises rated at £60 instead of £100 as in 1904. Reference to table 5.5 will show that whereas in 1913 the majority of occupiers (58%) paid at the lowest rate and only one fell into the highest category, by 1924 the distribution had changed so that larger proportions of the consumers paid at higher rates and this trend is more marked in 1934. To illustrate this point, consider the proportion of payments falling into the lowest category. In 1913 58% of all payments were at or below 15p (3/-) per quarter. In 1924 only 5% of rents fell into the lowest category of 30p (6/-) or below and in 1934 on the same scale of charges only 2% of the payments lay in this sector. The general effect of these changes was to increase the number of payments in the middle range. Even under the higher charges of 1934 the highest pay-

ment made was only £2.75 (£2.15s)per quarter, and the lowest payments were as little as 40p (8 shillings).

As well as being consumers of the Company's water the citizens of the town also held its shares; the Company was predominantly owned by the local people. Table 5.6 shows the distribution of shareholders by place of residence in 1917, 1927 and 1937, based on the surviving registers of shareholders.[33]

**Table 5.6: Distribution of Shareholders by Distance of Residence From Alcester**

| Year | 0-10 | 11-25 | over 25 | Total |
|---|---|---|---|---|
| 1917 | 36 | 7 | 4 | 47 |
| 1927 | 28 | 10 | 5 | 43 |
| 1937 | 27 | 6 | 6 | 49 |

(From the Company's Register of Shareholders)

The analysis presented in the table shows that the Company was predominantly a local concern with 70% of the shareholders living within 10 miles of the town and no more than 15% of shareholders over 25 miles away.

The same pattern is repeated if we consider the distribution of shares rather than shareholders, taking 1917 as a typical year. Table 5.7 displays the results of the analysis. Here the local contribution is even more marked with 78% of the ordinary share capital and 73% of the preference shares being held within 10 miles of Alcester, the majority of these in Alcester itself.

**Table 5.7: Distribution of Size of Shareholding with Distance From Alcester in 1917**

| **Share type** | **Numbers of shares held at the specified distance (in miles)** | | | |
|---|---|---|---|---|
| | 0-10 | 10-25 | Over 25 | Total |
| Ordinary | 280 | 64 | 16 | 360 |
| Preference | 308 | 77 | 35 | 420 |

(From the Company's register of Shareholders)

Although the Company's capital was predominantly held locally in 1917, the results for 1927 and 1937 in table 5.6 suggest some tendency to outward diffusion of the shares. This seems to have taken place largely by inheritance, as is suggested by the fact that several of the shareholdings can be traced through various ownerships across this period. Certainly the shares were never quoted on the Stock Exchange and it seems that the shareholders were not keen to part with them.[34]

**Table 5.8: Distribution of Shares by Shareholders Occupation in 1917, 1927 and 1937**

| | | **Number of Shareholders** | | **Number of Shares** | |
|---|---|---|---|---|---|
| | **Occupation** | **Ordinary** | **Preference** | **Ordinary** | **Preference** |
| Year 1917 | Tradesmen & Shopkeepers | 9 | 6 | 73 | 47 |
| | Professional Men | 3 | 2 | 50 | 22 |

| | | Number of Shareholders | | Number of Shares | |
|---|---|---|---|---|---|
| | **Occupation** | **Ordinary** | **Preference** | **Ordinary** | **Preference** |
| | Spinsters & Widows | 10 | 7 | 76 | 179 |
| | Married Ladies | 5 | 2 | 38 | 25 |
| | Clergy, Nobility & Gentry | 6 | 6 | 86 | 61 |
| | Farmers | 3 | 3 | 25 | 26 |
| | Manufacturers | 2 | 2 | 12 | 60 |
| | Totals | 37 | 28 | 360 | 420 |
| Year 1927 | Tradesmen & Shopkeepers | 10 | 5 | 83 | 60 |
| | Professional Men | 1 | 2 | 5 | 32 |
| | Spinsters & Widows | 11 | 8 | 122 | 180 |
| | Married Ladies | 4 | 2 | 26 | 35 |
| | Clergy, Nobility & Gentry | 8 | 7 | 112 | 106 |
| | Farmers | 2 | 2 | 10 | 15 |
| | Manufacturers | 0 | 0 | 0 | 0 |
| | Totals | 36 | 27 | 360 | 420 |
| Year 1937 | Tradesmen & Shopkeepers | 9 | 7 | 57 | 72 |
| | Professional Men | 2 | 2 | 15 | 32 |
| | Spinsters & Widows | 7 | 5 | 54 | 79 |
| | Married Ladies | 4 | 5 | 88 | 87 |
| | Clergy, Nobility & Gentry | 9 | 5 | 127 | 141 |
| | Farmers | 1 | 1 | 19 | 9 |
| | Manufacturers | 0 | 0 | 0 | 0 |
| | Totals | 31 | 25 | 360 | 420 |

(The information for table 5.8 comes from the Company's register of shareholders)

Table 5.8 shows the distribution of the shares by occupation of shareholders in 1917, 1927 and 1937. Certain occupations show a greater tendency to hold shares of a particular type than others. Widows and spinsters in 1917 and Clergy, Nobility and Gentry (included with these are retired persons and those regarded as having no occupation) in 1937 predominated as holders of the Preference Shares. This might indicate that these shares were regarded as very safe investments in the town.Finally table 5.9 shows how the shares were distributed in terms of size of holdings in 1917, 1927 and 1937. The Company is shown to be a concern of small shareholders, with 50% of the shareholders holding 5 shares or fewer. Only one held more than 36 ordinary shares, and only one held more than 40 preference shares. The picture is not very different in 1927 or 1937, with the majority of holdings still being of fewer than 6 shares.

## Table 5.9: Distribution of Shareholdings in 1917, 1927 and 1937

| | | Share Type | | | |
|---|---|---|---|---|---|
| | | Ordinary | | Preference | |
| | Number of Shares held | Number of Shareholders | % | Number of Shareholders | % |
| Year 1917 | 0-5 | 19 | 50 | 9 | 32 |
| | 6-10 | 11 | 29 | 5 | 18 |
| | 11-15 | 1 | 3 | 3 | 11 |
| | 16-20 | 3 | 8 | 6 | 21 |
| | 21-25 | 1 | 3 | 1 | 4 |
| | 26-30 | 1 | 3 | 2 | 7 |
| | 31-35 | 1 | 3 | 0 | - |
| | 36-40 | 1 | 3 | 1 | 4 |
| | Over 40 | 0 | | 1 | 4 |
| | Totals | 38 | | 28 | |
| Year 1927 | 0-5 | 17 | 47 | 8 | 30 |
| | 6-10 | 11 | 31 | 5 | 19 |
| | 11-15 | 1 | 3 | 3 | 11 |
| | 16-20 | 3 | 8 | 5 | 19 |
| | 21-25 | 0 | 0 | 1 | 4 |
| | 26-30 | 2 | 6 | 3 | 11 |
| | 31-35 | 1 | 3 | 0 | 0 |
| | 36-40 | 0 | 0 | 1 | 4 |
| | 41-45 | 1 | 3 | 0 | 0 |
| | 46-50 | 0 | 0 | 0 | 0 |
| | Over 50 | 0 | 0 | 1 (59 shares) | 4 |
| | Totals | 36 | | 27 | |
| Year 1937 | 0-5 | 16 | 52 | 8 | 33 |
| | 6-10 | 7 | 23 | 4 | 17 |
| | 11-15 | 2 | 6 | 2 | 8 |
| | 16-20 | 3 | 10 | 3 | 13 |
| | 21-25 | 0 | 0 | 2 | 8 |
| | 26-30 | 2 | 6 | 2 | 8 |
| | 31-35 | 0 | 0 | 1 | 4 |
| | 36-40 | 0 | 0 | 2 | 8 |
| | 41-45 | 0 | 0 | 0 | 0 |

| | Share Type | | | |
|---|---|---|---|---|
| | Ordinary | | Preference | |
| Number of Shares held | Number of Shareholders | % | Number of Shareholders | % |
| 46-50 | 0 | 0 | 0 | 0 |
| Over 50 | 1 (65) | 3 | 1 (59) | |
| Totals | 31 | | 24 | |

(The information for table 5.9 is taken from the Company's Register of Shareholders)

It has been shown above that the Alcester Waterworks Company did have an effect on the health of the community it served and that it was predominantly a local concern with its capital raised and the shares held by the citizens of the town. It now remains to set it in the context of piped water supply in Warwickshire in the early twentieth century.

Evidence on this matter may be obtained from *The Return as to Water Undertakings*. Part II of this survey gives details of the supplies in urban and rural areas for each county in England and Wales. The relevant entries for Warwickshire, in condensed form, are given in table 5.10. The striking feature of the results displayed is the very high percentage of houses supplied in the urban districts, very nearly 99% of the total. Four towns, Coventry, Birmingham, Leamington Spa and Sutton Coldfield as having particularly high percentages of houses supplied with piped water All these towns listed except Kenilworth and Sutton Coldfield were supplied by local authorities tics; the other two were supplied by limited companies.

**Table 5.10: The Extent of Piped Water Supplies in Warwickshire , 1913 (**From *The Return as to Water Undertakings*)

(a) Urban Districts

| | Total Houses | With piped water | % of total |
|---|---|---|---|
| Birmingham CB | 177,555 | 177,030 | |
| Bulkington UD | 444 | 0 | |
| Coventry UD | 23,042 | 22,999 | |
| Kenilworth U.D. | 1,369 | 1,195 | |
| Nuneaton U.D. | 7,590 | 7,074 | |
| Royal Leamington Spa | 6,162 | 6,140 | |
| Rugby U.D. | 4,639 | 4,639 | |
| Stratford on Avon Borough | 1,985 | 1,525 | |
| Sutton Coldfield Borough | 4,607 | 4,350 | |
| Warwick Borough | 2,742 | 2,712 | |
| Totals | 230,135 | 227,664 | |

Overall percentage of houses with piped water = 98.9%

(b) Rural Districts

| | Total Houses | With piped water | % of total |
|---|---|---|---|
| Alcester | 2,851 | 1,030 | 36.1 |
| Atherstone | 4,266 | 3,892 | 91.2 |
| Brailes | 1,544 | 1.006 | 65.2 |
| Coventry | 353 | 315 | 89.2 |
| Farnborough | 365 | 119 | 32.6 |
| Foleshill | 4,888 | 3,764 | 77.0 |
| Meriden | 3,476 | 1,198 | 34.4 |
| Monks Kirby | 402 | 0 | 0 |
| Nuneaton | 558 | 227 | 40.7 |
| Rugby | 4,103 | 1,213 | 29.6 |
| Solihull | 4,521 | 106 | 24 |
| Southam | 2,467 | 621 | 25 |
| Stratford | 2,597 | 747 | 28.8 |
| Warwick | 2,707 | 45 | 1.77 |
| Totals | 35,098 | 14,283 | |

Overall percentage of houses with piped water = **40.75**

In Rural Districts the situation was very different. The overall percentage supplied with piped water is scarcely over 40%. Excluding the three exceptional districts of Atherstone, Coventry and Foleshill, which had a large proportion of urban development, the percentage of houses supplied is low, Alcester being one of the lowest at 36%. Of this low proportion almost all the houses connected were in Studley and Alcester parishes; fifteen of the nineteen parishes in the Alcester Rural District had no piped water at all. There were only two suppliers in the rural district: the Alcester Waterworks Company and the East Worcestershire Waterworks Company, which supplied the Studley and Ipsley parishes.

In rural areas for the most part the people depended upon springs or wells for their water. These were usually described as ‘Good and Sufficient’ or ‘Fair and Sufficient’ or in some similar way in *The Return as to Water Undertakings*. In the Foleshill Rural District the wells were described as ‘usually shallow and unsatisfactory’, but nevertheless 23% of households depended upon them.

The Brailes Rural District was unusual in that the proportion of houses with piped water was relatively high at 65%, even though the district, in the south east of the county, was almost entirely rural in nature. The high proportion of piped supply is a result of the activities of private proprietors in the area, such as Lord Redesdale and the Earl of Camperdown who supplied water to the villagers, as well as their estate cottages. Brailes Rural District Council also supplied water on a small scale to 160 houses in Brailes itself and a further 125 in Long Compton village. In conclu-

sion, the Alcester Waterworks Company may be seen as a creation of the local community, interacting with it in terms of public health and economics and very much a product of its time and place.

## Notes and References to Chapter 5

1. Second annual report of the chairman at the annual general meeting of 2nd February 1880, WRO, CR 114a/736.1
2. WRO, CR 51/92. Minute of meeting of the Rural Sanitary Authority including report of the Medical Officer of Health, 23 September 1879.
3. AC, 13th September, 1879.
4. Ibid
5. Minute of meeting of the Rural Sanitary Authority, 15 September, 1879. WRO, CR 51/92.
6. R.S.A. minute. 30th September 1879, WRO, CR 51/92.
7. AC, 4th October 1879.
8. Stratford-on-Avon Herald 6th February 1881; Chairman's report to the third annual general meeting.
9. Stratford-on-Avon Herald, 9th February 1881.
10. The deputation consisted of the chairman and one director.
11. Stratford-on-Avon Herald 9th September 1881. Report of meeting of the Rural Sanitary Authority.
12. Ibid.
13. Minute of meeting of the RSA 11th October 1881, WRO, CR 51/92.
14. Minute of meeting of the RSA 29th November 1881 , WRO, CR51/92.
15. Minute of RSA meeting 27th December 1881, WRO, CR5l/92
16. Minute of RSA meeting 20th March 1883, WRO, CR5l/92.
17. Verbal report from Mr. A. Gwinnett, formerly assistant secretary of the Alcester Waterworks Company.
18. Minute of meeting of the RSA 7th August 1883.
19. AC, 7th March 1891. Report of RSA meeting.
20. AC, 7th February 1885. Report of annual general meeting of the Waterworks Company.
21. Undated newspaper cutting from Alcester Chronicle, in Ragley collection, WRO, CR 114a/736,1.
22. Report of Medical Officer of Health for the combined districts for 1882. ROW, B.A. 837,250-2
23. Ibid.
24. Ibid. Report for 1886.
25. Ibid. Report for 1888.
26. See Chapter 2.
27. Booker , J. ; *Essex and the Industrial Revolution*, Essex Record Office Publication No.66, 1974, page 172.
28. See Chapter 2.
29. Minute of RSA meeting 8th January 1878. WRO, CR 51/92.
30. See Chapter 2.
31. WRO, CR 1547/357-360.
32. *The Return as to Water Undertakings in EngIand and Wales*; H.M.S.O. 1915, Part II.
33. WRO, CR 1547/353--355.
34. Verbal report from Mr. A. Gwinnett.

## Chapter 6 : The End of The Company

The provision of piped water after the Second World War was affected by two pieces of legislation. The Water Act of 1945 revised the regulation of public water supply in a number of respects, in particular giving the Minister of Health power to control and direct national water policy. He was to be supported by a Central Advisory Committee. Of more immediate importance in the Alcester area was the Rural Water Supplies and Sewerage Act of 1944, which set aside some £15 million of central government funds for contributions to schemes for water supply and sewerage in rural areas.

The neglect of rural areas in these respects was a result of the high investment needed in mains and distribution equipment for a dispersed set of consumers, so that supplying them could not be a commercial proposition for a limited company, and local authorities were unwilling to commit their ratepayers to such a heavy burden. The 1944 Act made it the duty of every local authority to provide a water supply to each rural locality in its area; statutory undertakers might be required to supply rural areas under guarantee.

Although the pressures of war upon the economy delayed the implementation of the 1944 Act, extensions of the mains to airfields, army camps and isolated farms made it possible to begin to improve the situation in rural areas as soon as peace-time conditions were restored. As a preliminary step the Alcester Rural District Council called for a report on the water supplies of its area. Compiled by J. D. and M. Watson, Engineers, of Westminster, the report stated that seven villages and hamlets in the council's area were still without piped supplies, and that three separate supplying sources provided the water which was available.[1] These sources were:

1 . The East Worcestershire Waterworks Company supplying Studley and Astwood Bank.

2. The Alcester Waterworks Company.

3. The Council's own source at Dunnington, which supplied Bidford and Salford Priors from a borehole, the water being lifted by electrically powered turbine pumps to a reservoir, whence it gravitated to the consumers.

The engineers advised that the Alcester Waterworks Company should be taken into public ownership although ‘ .....only the mains only were likely to be of use.’ They went on in the report to comment that :

> .....it would seem that the Alcester Waterworks Company have performed an essential public service for the past 50 years or more and are now not unwilling, on fair terms, to hand over their responsibilities to public control, this being in line with modern practice.’

Finally it was suggested in the report that the Company's supply should be replaced by water purchased from the East Worcestershire Waterworks Company until the Coventry aqueduct was completed.

This report was accepted by the Rural District Council who soon had a scheme prepared which provided for the purchase of the Alcester Waterworks Company. This was submitted to the Minister of Health for approval before the end of 1946, the nominal sum of £100 being allowed

for the purchase of the company since no valuation was then available.[2] Negotiations with the latter were soon in progress however and in a letter dated 28th May 1947 the Council was informed that the valuers, W. B. Keen and Co., were in a position to report with regard to the value of the concern.[3]

Agreement between the valuers and the directors of the Company on terms for the transfer of the undertaking was minuted on 19th November 1947 as follows :

1 . Subject to the approval of the minister of Health the date for transfer shall be 1st April 1948.

2 The undertaking to be transferred shall be the whole £18 of the undertaking as it exists at 1st April 1948, including all property whatsoever belonging to the Company, both real and personal (except the Directors Minute Books) and in particular including cash at the bank and in hand.

3. The Rural District Council shall take over all debts due to the Company and take over all liabilities of the Company existing at the time of transfer.

4. The Council shall pay the Company the sum of £9,000 as compensation for the transfer of the undertaking.

5. The Company shall, out of the said sum of £9,000 meet all claims for compensation and the costs of winding up.

6. If the £9,000 is not paid on or before 1st April 1948 the Council shall pay the Company interest on that sum at the rate of 4% per annum until the date of payment.

7. The payment of £9,000 is subject to the necessary loan sanction being obtained from the Minister of Health.

The Council resolved to accept these terms and offer £9,000 for the Company; in fact this sum represented slightly more than the book value of the the Company's assets in 1947.[4] The purchase of the Alcester Waterworks Company was only a part of the Rural District Council's scheme for water supply improvement. The plan involved expenditure of £65,750, and a public enquiry into this proposal was held in Alcester on 29th January 1948.

On the 1st. February 1948 the Alcester Waterworks Company held its last annual general meeting, almost exactly 69 years after the first. The last Chairman, Mr George Clark, in his speech said that :

.....although formed in a small way, the Company has made improvements from time to time in order to increase the supply but even this was inadequate at times, especially during the drought. When war seemed inevitable in 1938, the Directors decided to harness the Kinwarton spring, and as a result there was no interruption of the supply during the war."

A final dividend of 10% on ordinary shares was declared, and Mr. E. Mackay of Colchester, described as one of the oldest and largest shareholders, congratulated the Directors on their conduction of the Company.[5] This was the last corporate act of the old Company; on the 14th of April 1948 the Rural District Council was informed that the Alcester Waterworks Company had been

acquired as from 1st April 1948.[6] However, although the Company had ceased to exist, its works remained in use for some years afterwards. Water continued to be drawn from Arrow until 1953[7] and the Kinwarton pumphouse was still in use as recently as 1965, having been transferred to the East Worcestershire Waterworks Company from the Rural District Council in 1960. This Company still has rights to draw water from Kinwarton, although none is in fact taken; the pumping station is retained as standby source.[8] Thus the Company came to an end after nearly seventy years of service to the town of Alcester and the water supply became the direct responsibility of the local authority, as had been envisaged when the need for piped water first became evident in the 1870's.

It is now necessary to consider what light the story of the Alcester Waterworks Company can shed on the general history of water provision in Britain. It is clear that the Company was a small concern any standards; it never served more than 2,500 people at the very most, but this is in part a source of interest, for while the history of large scale water provision for the; great towns is well known, less attention has been given to the small providers of public water.

Study of a small water undertaking prompts a number of questions which might be expected to have interesting answers. What forces might bring such a small concern into being? What pressures might have influenced technological decision making when the scheme was being designed? How was the Company's financial performance related to the technology used? What technological resources would a Company of this sort need to draw upon in its day to day operation? How did interaction between the Company and its consumers affect the Company's history in general and its technical history in particular? What can a study of the visible remains of the Company's operation yield, which could not have been otherwise obtained? The answers to these questions should be of general significance in the history of water supply in Britain, although it may be that they will be adding fine detail to our knowledge rather than providing a broad outline.

One of the striking feature of the history of public water supply for Alcester is its early date in relation to the population of the town. In 1880 for example only six Warwickshire towns and no villages at all had a supply of piped water. The towns were Birmingham, Coventry, Leamington, Rugby, Warwick and Alcester. All except the last had populations of 11,000 and more, Alcester being about 2,000. This is striking enough in itself; even more so is the fact that a number of towns with populations larger than Alcester had no piped supply as late as 1890, Solihull and Bedworth being examples.

Public health legislation in the 1870's was an important stimulus in the provision of water supply, particularly after the establishment of the local sanitary authorities with their Medical officers of Health. The latter could have a very important influence on the course of events at a local level if the man appointed to the post was active and conscientious, as the Medical Officer of Health for the Alcester Rural District at seems to have been, and the early date of the town's water supply must at least in part be attributed to him. On the other hand, he served the Urban Sanitary Authority of Stratford in the same capacity, and that town was without piped water until 1886. Some explanation must be sought for this discrepancy.

In an interesting study of the early history of the Board of Health in Stratford, Penny has

pointed out that most of the support for sanitary reform in the 1850's came from what he has termed the 'social elite' of the town, and most of the opposition from the lower middle class ratepayers, mostly small shopkeepers and the like. In fact at one point a petition calling for the disbanding of the Board of Health was signed by three-quarters of the town's ratepayers, when the Board proposed to spend no less than £10,000 on draining the town and providing a water supply. However the small ratepayers were able to exert their influence more effectively than this, for the Corporation of the town was able to appoint a number of members to the Board of Health from its own ranks, and indeed candidates did stand at Corporation elections as representing the 'anti-Board interest.'[9]

In Alcester on the other hand there was no public health body until the formation of the Rural Sanitary Authority in 1872; in fact the Board of Guardians acted as the Rural Sanitary Authority just as at the same time the Corporation in Stratford took over the responsibilities of the old Board of Health in becoming the new Urban Sanitary Authority. The Alcester Board of Guardians, although elected, was dominated by the 'social, elite' of the town and particularly by the Marquess of Hertford, who as a friend of the Prince Consort was no doubt an ally of social progress and sanitary reform. Thus although the opposition to sanitary reform in the town was as violent as in Stratford, and based in the same social class, it was less effective, at least partly because the opposition had less experience of operating through the political machinery which was available.

In addition to the attitude of the Medical Officer of Health and the relationship between the lesser ratepayers and the Rural Sanitary Authority, an important influence was exerted by the Local Government Board. There seems to be no doubt that the uncompromising report upon the sanitary state of the town which the Board's inspector delivered to the Rural Sanitary Authority in person, acted as a sort of prime mover to all the activity that followed; the Sanitary Authority's own Medical Officer had reported in similar terms some months before the visit of the Local Government Board's man without any marked result.[10] It seems in fact as though the Rural Sanitary Authority was somewhat in awe of the Local Government Board, and unsure of both its own powers and those of the central government in sanitary matters. This uncertainty over the powers of local as opposed to central authority has also been noted by Booker in relation to the provision of water supply in Essex, where he suggests that such uncertainty tended to delay the provision of a public supply to a number of towns.[11] Nor is such doubt to be wondered at, for the 60's and 70's of the nineteenth century saw such a welter of public health legislation that confusion must have been almost inevitable. Uncertainty over these matters in Alcester is shown by the attempt made by the rate-payers to form a Local Board of Health, presumably with the intention of acting more independently of the Local Government Board; the application was rejected by the latter.[12]

What would have happened if the Rural Sanitary Authority had simply refused to take any action to improve the drainage of the town and its water supply it is difficult to say. In all probability very little. The Local Government Board did take action in a similar case in the town of Thetford in Norfolk. This town was also dependent upon shallow, polluted, wells like Alcester was, and came to the notice of the Local Government Board. However despite several stern reminders about the poor sanitary state of the town, the local authority still dragged its feet, and

eventually the Local Government Board held a public enquiry in the town to investigate the delay. Even after this it was some time before the town's waterworks was built. Once again, as in the case of Alcester, all sorts of remedies to make the well water acceptable were sought so as to avoid the expense of the waterworks, and were likewise abandoned.[13]

Poor though Alcester's sanitary condition was in the 1870's, it was probably no worse than in many other small towns and better than some. The report upon the state of the town made by the Local Government Board's inspector was couched in the sort of terms which were commonly used for such reports, indicating that everything was bad but that improvements were possible. The effect of the report seems to have been to convince the Rural Sanitary Authority that the eyes of the Local Government Board were upon the town.

Thus it would seem that the important influences which brought about the water supply to the town and thus might, by inference, be likely to be important with regard to other small towns were the attitude of the Medical Officer of Health, the composition of the Local Sanitary Authority and the history of local government in the area, and the extent to which the Local Government Board interested itself in the matter.

While these factors seem to have been important in determining whether Alcester should have piped water or not it must be remembered that the water could be supplied by a commercial undertaking operating for profit, or by the local authority acting as a supplier in its own right. In Alcester's case the first alternative was ultimately taken although the second had been the original intention of the Rural Sanitary Authority. Booker has pointed out that in consideration of the provision of piped water in the nineteenth century the question of drainage must always be taken into account; indeed the two are often inextricably intertwined.[14] Usually the local authority proposed both to drain the town with effective sewers and to provide piped water as in Alcester; the Local Board of Health in Stratford intended the same in its scheme in the 1850's. In both towns however the proposals met with opposition which resulted in Stratford having sewerage from the 1850's but no piped water until 1886 whilst in Alcester the Rural Sanitary Authority modified its plans so as to provide the town with piped water but abandon the plans for sewerage. In the event the town got its sewerage scheme as well, after an epidemic of diphtheria struck the town in September 1877, and under pressure from the Marquess of Hertford the Rural Sanitary Authority decided to put into effect the sewerage scheme which had been proposed two years earlier but abandoned.

With regard to the decision to form a company rather than to have the water provided by the Rural Sanitary Authority however, it is difficult to decide what part was played by opposition from the smaller ratepayers and what part by the manoeuvres of the secretary of the Rural Sanitary Authority, John Langston Jones; insufficient documentary evidence has survived to allow this question to be answered. It is certain that the Sanitary Authority's scheme to impound the Spittle Brook and supply the town by gravity, depended heavily upon the goodwill of the Marquess of Hertford as any scheme in the Alcester area was bound to do, for he owned most of the land around the town. On the other hand there is plenty of evidence that the Marquess was favourably disposed towards the proposals of the Rural Sanitary Authority, and indeed went to some trouble

in enquiring into sanitary schemes in other parts of the country, and corresponding with sanitary engineers to obtain their views upon the technical details of plans made by Pritchard, the consulting engineer engaged by the Sanitary Authority. What the Marquess was concerned about was the question of how the scheme was to be paid for, being unwilling for the burden of the rates to fall upon the tenant farmers of the Ragley Estate, who would receive no benefit from the scheme. Even so, when the plans for the Alcester special drainage district proved abortive the Marquess did not withdraw his consent from the Spittle Brook scheme until prompted to do so by Langston Jones. What the latter's motive was in doing this can only be guessed at. Certainly he was heavily involved in the legal business to do with the Company when it was formed and perhaps saw opportunities to gain some advantage if the local authority scheme was abandoned leaving the way open for the Company to step in.

Whatever the exact mechanism of the process whereby the water supply of the town was given over to a limited company, the result was to have considerable repercussions of a technical nature. For among the leading promoters of the Company were men who had been loud in their condemnation of the local authority's scheme when it seemed likely that they might have to pay for it themselves through the rates, and among the grounds for their criticism was the inadequacy of the supply. The Company therefore could not simply take over the Spittle Brook scheme and had to look elsewhere; as a result the Company was left with a system which involved the expense of pumping, and a supply derived from inadequate sources, namely the well at Arrow and the Oversley springs. These problems were to affect the Company for a number of years.

The problems of running costs and supply volume, would be likely to affect any small concern whether a commercial undertaking or a municipal scheme, but commercial pressures would not affect the technical planning of the latter directly. However the fact remains that being small such a concern would not be able to realise the economies of large scale production, which would rule out steam power for pumping. The small scale of the operation would also tend to rule out upland catchment schemes with their heavy capital expenditure especially if the water was to be conveyed for any considerable distance. In fact a small concern in the 1870'S. like the Alcester Waterworks Company would face a considerable dilemma being unable to face the recurrent costs of steam pumping, or the heavy capital expenditure of an upland catchment area scheme. Under these circumstances water power for pumping would be a natural choice provided that adequate supplies of water were available. Thus one would expect that the directors of a small company of this type would tend to favour a scheme which minimised capital outlay (thus ruling out an upland catchment system) and use the cheapest possible power source. This would probably be water power, and in an area where water power had been extensively exploited in the past, and was still in active use in the late nineteenth century, it is not surprising that the directors chose it for the Alcester Waterworks Company.

It has been shown that this decision did not meet with the approval of John Millward the consulting engineer, who considered that the power available from the Rock Mill Stream was inadequate for the task intended, and recommended steam pumping.[15] He continued to advise against water power even when the suggestion to divert the waters of the Spittle Brook into the

Rock Mill Stream was made. Nonetheless he designed a system which did use water power, and was in some details different from what he had at first recommended. Presumably it was a matter of falling in with the Directors, wishes or losing the commission. The later events of the Company's history suggest that both views were wrong; the Company could not have afforded to run a steam engine on a permanent basis, and water power proved inadequate for the pumping duty required.

The question which now arises concerns the inadequacy of the water power. It was shown in Chapter 3 that had the water wheel been adequately supplied with water, it would have been able to cope with, the pumping duty required of it with a safe margin. In fact the appearance of the wheel suggests that the engineer who designed it was conversant with the best nineteenth century practice in such work. The failure of the water power was not a result of a design fault in this part of the scheme therefore, and since water power did prove inadequate (the Company having to hire supplementary steam power) it must follow that the wheel was not supplied with the water it required. This in turn raises a general point regarding hydrological practice in the nineteenth century. Smith[16] has pointed out that stream flow estimation was the weak point of nineteenth century hydrological work, and the usual method was to deduce it for a given stream from its catchment area found from a map and the known rainfall, a fixed proportion of the water being assumed to evaporate and the rest appearing as run-off in the stream in question. This procedure is now known to be open to considerable error and a modern engineer or hydrologist would estimate stream flow empirically, by building a weir of known cross-section across the stream and estimating the flow rate over it by careful measurements. Such observations would normally be carried on over a considerable period of time, preferably several years, so as to get some idea of the variability of flow rate and enable the data to be analysed statistically.

In the nineteenth century on the other hand, empirical observations were limited to one or two random measurements of the stream flow, probably by timing a floating object over a known distance. Under these circumstances, engineers' estimates of flow rate were subject to considerable uncertainty and it is not surprising that in the long run they were found to be seriously in error in many cases. In this instance then, the experiences of the Alcester Waterworks Company illustrate these defects of hydrological practice in the nineteenth century. The reasons for these practices among engineers, in relying upon rainfall data and catchment area to deduce flow rate, are probably threefold. Firstly there is the question of expense, since any prolonged series of observations was likely to be expensive in time and labour. Secondly the delay involved was likely to be unacceptable to any possible clients of the engineers and thirdly statistics was not a well-developed branch of mathematics, at least as far as its practical applications were concerned, until the early years of the present (20th) century.

What applies to the estimation of stream flow rates applies equally to the estimation of the yields from wells, boreholes and springs, and here again it seems that the engineer was over-optimistic. He paid only a brief visit to the town and probably relied heavily on local knowledge for his estimate of the probable yield from the Oversley springs. In the event the Company was short of water both for pumping and for supplying to its consumers and this should be attributed

perhaps to defects in customary practice as explained above rather than to negligence on the part of the engineer.

Thus the technical decisions made in designing the supply scheme of the Alcester Waterworks Company were made, as one might suppose, largely for commercial reasons, based on the requirements of minimising capital expenditure as well as recurrent pumping costs, and as a result water power was chosen for pumping and springs and a well for the source of supply. The fact that neither proved entirely satisfactory is a reflection of one of the defects of nineteenth century engineering practice.

The problem of pumping costs was insoluble until the internal combustion engine became a practical proposition in the shape of the four-stroke Otto cycle engine working on town gas or producer gas. This was a device able to produce power economically in small amounts and was admirably suited to the small waterworks and other small power users. Booker has surveyed the application of the gas engine in late nineteenth century Essex where the device was used by several small waterworks.[17] As far as the Alcester Waterworks Company was concerned the introduction of the gas engine was an important factor in the transition of the concern from a moribund state to profitability, as has been shown in Chapter 3.

One interesting point to arise from the introduction of the gas engine is the light which it can shed upon technical conservatism in the engineering profession at that time in the nineteenth century. For the gas engine was being made by Crossley Brothers in Manchester in the late 1870's and the engineer consulted by the Company, John Millward, could have suggested that the gas engine be used as a power source for pumping. The fact that he recommended steam power on grounds which turned out to be economically ill-founded must be attributed to professional inertia on the engineer's part, influenced perhaps by the poor performance put up by the Lenoir gas engine and the early models made by the Otto firm, which worked on the principle of using the explosion to create a vacuum rather in the fashion of the Newcomen steam engine. When the Company did adopt the gas engine in 1902 it does not seem to have been on the advice of any engineer, at least as far as it is possible to tell from the documentary evidence. Possibly the idea that these engines were an efficient power source spread among potential users by a sort of technical osmosis; certainly their use spread rapidly in Alcester from the late 1890's onwards, and this pattern seems to correspond with that found in Essex by Booker.

Another interesting feature of the technical history of the Company is the contribution made by practical men of affairs who were not technically qualified. Both Randell, Lord Hertford's agent, and Langston Jones, the Company's Solicitor, were able to argue upon technical matters without disgracing themselves; engineering, at least as applied to waterworks construction on the small scale, was not yet such a complex matter that educated men with a little common sense could not make a useful contribution. In fact the whole scheme as finally implemented with water-powered pumping, and water drawn from the springs in Oversley, had been put forward by Randell himself in a letter to Langston Jones, without, as far as is known, technical advice of any kind. The consulting engineer was called in mainly to work out the fine details of the scheme. Whatever

the reason for the delay in its application the gas engine played an important part in the eventual attainment of a profitable condition by the Alcester Waterworks Company and would have been likely to do so for any other small water undertaking faced with similar difficulties. Relatively cheap in capital cost, reliable and needing little attention, it was well suited to the duty which a waterworks company might require. The reliability arose partly from the very high standards of construction which manufacturers such as Crossley Brothers insisted upon, and partly from the nature of the gas engine with its low piston speeds and consequent low rate of cylinder and bearing wear, as compared with petrol, or high speed heavy oil engines.

The result was a reduced cost of pumping, with a consequent reduction in total costs, and although the improvement in the Alcester Company's position on was not solely due to this, (water rents being raised at the same time as the gas engine was introduced) the evidence does suggest that it was an important factor. The only limitation on the application of the gas engine was the provision of a supply of town gas, which eliminated its use at remote sites. It was possible to run the device on producer gas generated on the site from a coke furnace, but small users would perhaps be unlikely to find this an economic proposition because of scale effects. The needs of such remote-site users were better served by the oil-engine when finally perfected.

Next we must turn to the technological resources used by the Company in its day to day running. Both documentary and visible evidence make it clear that the Company used technological resources of the simplest kind, and drew these largely from its immediate locality. It employed no engineers on a regular basis, although professional men were consulted when the need arose from time to time. Likewise there was no permanent analyst, samples being sent off when need be to firms in Birmingham which undertook such work. The Company employed very few men and only one of these in anything like a technical capacity. He was responsible for the pumping machinery, gas engine and waterwheel, and even this was only a part-time occupation. For repairs to the waterwheel or gas engine the local firm of blacksmiths was employed except for more serious jobs when the firm of Ball Brothers and Horton of Stratford-on-Avon who described themselves as ‘Engineers and Water Diviners’ was called in. For repairs to the pumps and mains a local plumbing firm was used.

The Alcester Waterworks Company in fact used the simplest technology which it could; financial pressures meant that it could not have done otherwise On the other hand the technology which it did use, although simple, was effective nevertheless; the fact that the equipment could be repaired by local craftsmen was an advantage. Even when supplementary steam power was needed the Company made use of a farmer's ‘portable’ engine which was hauled into position and connected to the pumps by a flat belt. To the last the Company held to its simple technology policy, the pumping station at Kinwarton for example had electric power for pumping, but had the motor as a separate unit driving the pump by means of a 'V' belt. This was in the late 1930's. The Alcester Rural District Council's Pumping Station at Dunnington, built at about the same time to supply Bidford and Salford Priors was equipped with electric motors shaft-coupled to powerful turbine pumps in duplicate sets. Both seemed to have worked effectively but the comparison illustrates the point that whereas the Waterworks Company used the minimum possible equipment for a given

task, the Rural District Council made a generous provision of the most modern kind.

Such changes in the technical arrangements of the Company as were made came in response to pressure brought upon it, both by public opinion and as a result of the activities of the Rural District Council or the Rural Sanitary Authority as the local health authority. Such pressure produced the sinking of a new borehole in the 1890's, its deepening in the early 1900 's and ultimately the exploitation of the new spring at Kinwarton. The Medical Officer of Health seems to have acted as the chief watch-dog over the Company as might be expected, but until around 1914 his chief concern was with the quantity of the supply rather than its quality, probably for lack of any simple criterion by which the quality of the water might be judged. Bacteriological examination of the water came later. No recommendations were made with regard to treatment ; the Company's policy of supplying water without filtration being thought acceptable apparently. However a major change in policy on water treatment came about as a result of pressure from the Ministry of Health in the late 1930's. In April 1939 the Rural District Council minutes recorded the receipt of the Ministry's Memorandum No. 221 which suggested that frequent and regular analyses should be carried out in order to prove that water supplies could be provided 'without chlorination as was done in the Alcester area.'[18] The reason for the Ministry's activity in the matter was possibly the then recent outbreak of typhoid fever in epidemic form in Croydon – at least this was suggested by the engineer employed by the Rural District Council in connection with its own water supply scheme for Bidford and Salford Priors. This had been designed to supply untreated water but in October 1939 the routine treatment of the water by Chloros injection was recommended by the engineer.[19]

As a result of this pressure, the water supplies of both Bidford and Alcester were being chlorinated as a routine procedure from February 1941, the Alcester Waterworks Company, as usual, being somewhat behind the Local Authority itself in installing the new apparatus.[20] The introduction of chlorination (which was never made a legal requirement) illustrates the effect which epidemics both nationally and locally have had upon the development of Public Health legislation and upon the provision of public water supply. The Public Health Acts themselves were a consequence of the great cholera epidemics, Alcester obtained its sewerage scheme as a result of a diphtheria epidemic in 1879 and the growth of the Alcester Waterworks received considerable impetus from a typhoid epidemic which struck the town soon after the Company started to supply it. Public opinion, as far as this can be judged from what documentary evidence there is, seems to have been rather hostile to the Waterworks Company in its early days, probably because both owners and occupiers of property resented the payment of water rents. The chief objection represented in complaints to the Rural District Council was inadequacy of supply, and once this was remedied the Company enjoyed reasonably good relations with the people of the town. Older inhabitants of the town now, nearly thirty years since the company ceased to supply them, remember above all the extreme hardness of the water; at least one of the local medical practitioners recommended the water for this reason as excellent for the prevention of rickets.[21]

All in all the relationship between The Alcester Waterworks Company and its consumers was a rather uneasy one, and the result of this was some pressure from the Rural District Council,

which tended to produce a certain amount of technical change. In later years the development of the technology of water analysis enabled more effective pressure to be brought both by the local authority and central government in the shape of the Ministry of Health, fur improvement in water quality.

The study of the visible remains of industrial activity usually provides material of an illustrative nature which clothes the bare bones of the documentary evidence, and gives a fuller picture of what the concern was and how it worked. Only rarely is it possible to use visible evidence to solve problems which could not be solved with the aid of the documentary evidence, and even more rarely is it possible to make quantitative inferences of this kind.[22] Raistrick has pointed out that more can be made of the remains of waterwheels than almost any other kind of industrial archaeological evidence, and the inferences which it is possible to make from the remains of the wheel used by the Alcester Waterworks Company illustrate this point. The documentary evidence shows that:

(a) The Company initially used water power for pumping.

(b ) Supplementary power from a steam engine had to be used within a few years.

From this we may infer that the waterwheel was inadequate for the task of pumping, but we do not know why, nor is there any way of solving this problem from the documentary evidence available. There are two possible explanations; either the design of the wheel was at fault so that even if fully supplied with water it would have been unable to deliver the power required, or the design of the wheel was satisfactory but the water supply was inadequate.

The visible remains of the waterwheel enable the maximum power which it could deliver to be calculated from the size and number of the buckets and the radius of the wheel. The results of these calculations indicate that the wheel would have been effective if it had been supplied with sufficient water. Since it was defective the conclusion must be drawn that the water supply was inadequate, and that the engineer responsible for the design made an error in the estimate of the water supply.

It is also interesting to compare the Alcester Waterworks Company in detail with one of a similar kind close at hand. The only comparable company in Warwickshire was the Kenilworth Water Company which received its powers by the Kenilworth Water Order of 1882. At this time the population of Kenilworth at 3,300 was about 50% larger than that of Alcester at 2,300, and it was a far more prosperous town with a rateable value of £20,210 in 1880 as opposed to £7,672.[23] The proposals deposited with the plans for the Kenilworth water scheme in 1881 were for a well and pumping engines, with steam engines and boiler house, a water tower and service reservoir supplying high and low level service mains.[24] Apparently the scheme was modified by the time the company started to supply water, for *The Return as to Water Undertakings*[25] mentions only one service reservoir on 'Tainter's Hill'. Since the water tower (on the top of an adapted windmill) was on the same hill it seems likely that the water tower was the company's only service reservoir. Certainly the water tower remained in use until after the second war. Although the original proposition was for a well as the company's source, it appears that the first source to be exploited was an adit driv-

en into the sandstone 'on the Common at Kenilworth' as the Return has it. This is confirmed by R. A. Storey in a brief article on the public utilities of Kenilworth.[26] By 1915 two boreholes were in use, both over 200 feet deep, and the adit had been abandoned.

Steam power was used for the pumping however, and the company is said to have erected 'solid and dignified pumping houses' in 1884 and 1895.[27] The Company expanded with Kenilworth in the early years of this century, and by 1915 it was supplying 1258 houses in the town, and was collecting water rents to the value of £1,872.[28] Like the Alcester Company it did not use filtration, but it did carry out chemical analysis 'occasionally'. According to the report in *The Return As To Water Undertakings*, the Company was by now supplying 170,000 gallons per day, but had storage for only 24,000, that is a mere 0.141 days supply. At this time the Alcester Company was supplying only 31,000 gallons but had storage for 52,500, or about 1.7 days supply. This would appear to have been a much more sensible ratio of storage to supply, and certainly no calamity ever struck the Alcester Company to compare with that suffered by the Kenilworth Company in 1913, when the town's typhoid epidemic resulted in the firm having to pay out over £2,400 in compensation. [29]

By 1915 the Company was a large undertaking by the standards of the Alcester Waterworks Company, having total paid-up capital of no less than £14,000, made up of 2000, £5 ordinary shares, 400 £5 preference shares at 6% and £2,000 of debentures. It also had an overdraft at the bank of nearly £1,000. By contrast the Alcester Company had a total paid-up capital of only £3,900. In this year the Kenilworth Water Company paid no dividend on the ordinary shares, but this was rather an exceptional year, for it was still paying for the consequences of the typhoid epidemic. The Alcester Company collected only £425 in rents and managed to pay a dividend of 6%. It could be argued however, that the Alcester Company was financially comparable with the Kenilworth one, for its ratio of turnover to capital was roughly the same. Table 6.1 summarises the information about the two companies.

**Table 6.1: A Comparison of the Alcester and Kenilworth Water Companies**
(Based on Financial Reports of the companies, The Return as to Water Undertakings, and Minutes of Alcester Rural 'district Council)

| | Company | |
|---|---|---|
| **Items of comparison** | **Alcester Waterworks Company** | **Kenilworth Water Company** |
| Houses supplied | 470 (about) | 1258 |
| Capital | £3900 | £14000 |
| Water rents | £425 | £1,872 |
| Dividend on ordinary shares | 6% | nil |
| Ratio of turnover to capital | 0.11 | 0.14 |
| Water rent per house | £0.90 | £1.50 |
| Daily supply | 31,000 | 170,000 |
| Storage | 52,500 | 24,000 |

| Items of comparison | Alcester Waterworks Company | Kenilworth Water Company |
|---|---|---|
| Analysis | None | Chemical occasionally |
| Filtration | None | None |

Thus although the Kenilworth Water Company was without doubt a larger and more substantial concern, it was in many ways comparable with the Alcester Company and no doubt the greater wealth of the town which it served was an important factor in determining its greater financial status. Since water rents were charged on the rateable value of the properties connected, the Kenilworth Company had an advantage over the Alcester Company in this respect. As far as the water technology of the two was concerned, they were again comparable. Both used boreholes, neither used filtration, and neither did much in the way of analysis. The scale of the Kenilworth concern was such as to enable it to use steam power for pumping whereas the other used gas, but otherwise there were considerable similarities.

The Kenilworth Company was the nearest example to the Alcester Company which operated in Warwickshire in that they were the only two working under Provisional Orders. Most of the suppliers in the county were local authorities when *The Return as to Water Undertakings* was compiled. In fact one large concern which started as a limited company came under the control of the local authority, a common fate which was shared ultimately by the smaller ones. The large concern was the East Warwickshire Waterworks Company, set up by an Act of Parliament in 1882, which came under the control of the Nuneaton Town Council by the provisions of the Nuneaton and Silvers Coton Urban District Council Waterworks Act of 1899. The deposited plans of the intended company of 1881 show that the intention was to sink 'a well shaft or boring', with reservoir, pumping station, pumps and steam engine at Nuthurst Heath in Ansley parish near Nuneaton, together with another boring also completed with reservoir, pumps, etc., nearby.[30] The intention was to supply Nuneaton and the smaller towns around. By 1913 when *The Return as to Water Undertakings* was compiled, the waterworks, now under local authority control, drew water from three 'wells', yielding 636,000, 21,000 and 14,000 gallons. The water was filtered at a rate of 500 gallons per square yard of filter area per day, and there were five service reservoirs, two of which held more than 500,000 gallons. The waterworks supplied 671,000 gallons daily but carried out chemical analysis only, and that only once each year.

Coventry Town Council provided its town's water, deriving its powers from various Acts of Parliament dating from 1844. By the time The Return as to Water Undertakings was compiled, most of the town's water was purchased in bulk from Birmingham Town Council, although some was drawn from a well, with another well being kept for emergency use. More than three million gallons were purchased each day from Birmingham, and the well in use delivered nearly another million. No filtration was carried out, there were two service reservoirs each holding 1.5 million gallons, and the water was subjected to quarterly chemical analysis only. The daily supply was 2,090,957 gallons.

The history of Warwick's water supply is particularly interesting, partly because of the involvement of Edward Pritchard, C. E (who, it will be recalled, featured in the story of Alcester's

water supply) and partly because of the unusual nature of the scheme adopted. A very lucid account of the history was given by Pritchard himself in a paper presented to the meeting of the Association of Municipal and Sanitary Engineers and Surveyors – of which he was the Vice-President – in 1876 [31]. This meeting was held in Warwick; the inaugural meeting of the Association had been been held in the same town three years before.

In his introduction to his paper Pritchard explained that prior to 1852 the town had been supplied by a water wheel. The rising main was of lead, and the distribution mains mostly of wood. This all seems reminiscent of the schemes of Sorrocold in the sixteenth century. This was clearly unsatisfactory for the mid-nineteenth century and, in 1852 a firm of engineers was asked by the Local Board of Health to report on the town's water supply and suggest improvements. The consultants formulated a number of proposals namely:

(a) A gravity supply from Hatton Hill to the north west of the town. This was rejected after a dispute with the Railway Company (presumably the Great Western. )

(b) A gravity supply from Haseley (rejected by the Corporation of Warwick, Pritchard gives no reason)

(c) Supplying from a borehole close to the Union workhouse. (Borehole sunk to 400 feet but water proved salty.)

(d) All the above having been rejected, water was to be taken from the River Avon, filtered, then pumped to a tower near the town centre 180 feet above the pump well.

The scheme was completed in 1857 at a cost of £14,627. By the late 1860's the scheme was in serious difficulties. Although the supply was only intermittent, the water was said to be 'scandalously filthy' by Dr. Buchanan (the Medical Officer officer of the Local Government Board) in a report of 1868. He also noted that the water was ‘held by the inhabitants to be fit only for water closets, washing and watering gardens.’ The water was drawn from the River Avon about 1½ miles above the town; the river was contaminated with the sewage and industrial waste of Coventry and Leamington.

As a result of this uncompromising report the Local Board of Health resolved to take action, and in 1870 called in Edward Pritchard to report upon the possibilities of improvement. He first reported on the existing scheme and found that the quantity supplied was large, around 330,000 gallons daily or about 30 gallons per head, roughly twice the volume allowed in large towns in the North of England. Pritchard attributed this to waste, largely resulting from the excessive pressure in the service main but also due to the unrestricted use of the water for watering gardens. As well as all these other defects the water tank was too small! To supply this large quantity of water the pumping engines were kept at work for fifteen hours out of the twenty-four, but even so the supply was shut off from 9 p.m. to 6 a.m. The running costs of the scheme in 1870 (the year of Pritchard 's report) amounted to nearly £645.

Thus only a dozen years or so after spending more than £14,000 on a water scheme, the Local Board of Health was faced with starting all over again. Pritchard's first plan was to supply the town by gravity from reservoirs on Haseley Brook (although the earlier proposal was unknown

to Pritchard at this time). He proposed to construct two reservoirs amounting to storage for 23,544,875 gallons which would give the town 188 days supply, assuming daily consumption of 275,000 gallons and a minimum flow in the brook of 150,000 gallons per day. Pritchard proposed this solution to the town's problems in 1871 and the result was the Warwick Waterworks Act of 1872 which provided the Corporation with powers necessary for implementing the scheme.

Nothing seems to have been done for some time however, and in 1873 Pritchard published a pamphlet setting out the details of his scheme, including with it a supplement giving out particulars of other gravitation schemes in the United Kingdom; and demonstrating that Warwick would have (if his proposals were put into effect) storage such that only six of the fifty-nine towns so supplied would have greater reserve supply capacity.[32] His estimate of the cost in 1871 had been £15,000, or £770 per year for 50 years at 3½%. In the pamphlet of 1873 he estimated that the cost had increased by £3,000 - £4,000 since 1871.

Whether this publication was intended to stimulate the Corporation to action it is hard to say; obviously doubts had been expressed as to whether the flow of the brook and/or the storage would be adequate, since Pritchard went to great lengths to defend his scheme by quoting rainfall statistics, stream gaugings, etc., as well as assembling the data for the supplement. All this is very reminiscent of the attacks on Pritchard's Spittle Brook gravitation scheme for Alcester and as in that case it is not possible to say whether the objections were based on fact, or were simply being used by an 'anti-spending' contingent of the Corporation to discredit the scheme, or at least delay it.

These questions are somewhat academic, because the scheme was never started; Pritchard produced a new idea himself. This was suggested to him by test boring carried out at Haseley in 1872-3. Upon these results he concluded that 'a very considerable quantity of water might be obtained by tapping the subterranean reservoir' formed in sandy drift deposits close to Haseley Brook. After further tests Pritchard concluded that 'an immense volume of very pure water might be obtained 'which if properly managed will require no filtration.'

Eventually Pritchard redesigned the scheme to eliminate the reservoirs completely, and draw no water from Haseley Brook at all. No filtration was employed; after collection from the aquifer by means of perforated collection pipes fifteen inches in diameter, the water gravitated to Warwick, where it was stored in a water tower before supply to the consumers. The scheme was approved by the local Government Board Inspector (Mr. I. Harrison, C.E.) at a public enquiry held in Warwick on 12th November 1874, and work commenced shortly afterwards. By thus eliminating the expense of both filter beds and reservoirs, the engineer must have encouraged the Corporation greatly, and the fact that soon after the adits were installed in the aquifer they were yielding '500,000 gallons per day of an excellent quality of water' must have been good news to Pritchard himself.

However, the scheme must have been found wanting at some time, for a reservoir was eventually constructed at Hatton, with a small pumping station to lift water up from the adit to it. The pump was powered by an oil engine. The adit itself was extended with a further sequence of

perforated pipes in 1888 and 1929. In the latter year the pipes were relaid in parts to eliminate the need for pumping, but the engine house remains although the 17 horse power Crossley oil engine and the 7 inch centrifugal pump which it once contained were removed in 1929.[33]

In *The Return as to Water Undertakings* the Warwick Waterworks is stated to use two sources, the Haseley adit system as described above, which is said to yield 232,360 gallons, and could give a further 70,000 per day if necessary, and a well in the sandstone at Woodloes. The latter was said to give 19,800 gallons daily 'and a further 130,000 gallons could be obtained'. The waterworks was then supplying 249,660 gallons daily to its consumers, and selling a further 2,494 in bulk. It used no filtration, and the storage at Hatton was 500,000 with a further 25,000 gallons stored in a service reservoir on Hatton Hill. The supply was subjected to periodical chemical analysis only. The Haseley adits were still partly supplying the town of Warwick in 1976 and Pritchard's scheme, although modified through the years, would seem. to have deserved the praise bestowed upon its designer at the meeting of the Association of Municipal and Water Engineers and Surveyors in 1876. The description of it as 'a scheme unique in character' by a Mr. C. Jones of Ealing however, was soon made false by the Kenilworth scheme referred to above, which also used an adit as a water source.[34]

Pritchard was also involved in the Stratford-on-Avon water scheme which started to supply the town in 1886, more than seven years after its much smaller neighbour, Alcester, first received piped water. It was mentioned above that the water scheme proposed by the Local Board of Health of the town in the 1850 's was thrown out on the ground of expense , although the less expensive sewerage scheme was taken up. Nevertheless there was an undercurrent of opinion in the town, mostly among the social elite no doubt, which was strongly in favour of the town having a decent water supply instead of the shallow wells which, as in the case of Alcester, were a potential health hazard.

As a result of complaints about the stench from the sewers, the Corporation, which acted as the Urban Sanitary Authority from 1872 onwards, had laid drainage pipes in the streets, and arranged to purchase water for flushing the sewers from the Stratford-on-Avon Canal Company. Late in 1881 however, the citizens of town were astounded to hear that a company was to be floated to provide Stratford with water, to which end an Act of Parliament was to be procured in 1882.[35] The deposited plans to accompany the Stratford-on-Avon and District Water Bill as it was to be called reached the Clerk of the Peace in Warwick on 30th November IBM; they showed that the intention was to pump water from a well to be sunk near Snitterfield to the north of the town, filter it, and supply the town by gravity from a service reservoir. The engineers were Joseph Quick and Sons.[36]

The identities of the promoters of this scheme seem to have been something of a mystery, but the Stratford-on-Avon Corporation soon resolved to oppose it, for which it was criticised by *The Stratford-on-Avon Herald*. In a leader of 16th December 1881 the newspaper pointed out that an efficient water supply would be essential sooner or later. If the town was not in a position to supply itself, opposition before a the Parliamentary Committee would be fruitless and hundreds of

pounds wasted. A series of meetings of the Corporation (acting as the Sanitary Authority) which shed an interesting light on the attitudes of the members to the water supply, were reported over the next few months. Some objected on the grounds that the supply was not needed, others that if the town could not afford its own supply nobody else should be allowed to provide one. Some opposed the Corporation's intended opposition to the Bill on the grounds that it would involve needless expense to no avail. Others thought that the Corporation's hand was being forced and yet another body of opinion hoped that the water scheme would go ahead but prove unprofitable so that the Corporation would be able to buy it up cheaply in a year or two.

Despite a letter from the Local Government Board refusing to sanction the Corporation' s opposition to the forthcoming Bill, the latter decided to oppose it by a majority of seventeen to seven.[37] Having done so however it had to decide on what grounds to oppose, and the only ones likely to carry any weight seemed to be that the Corporation would undertake its own water and sewerage scheme. Even this met opposition in the meetings with some councillors objecting that the water would be a charge on the rates whether the ratepayers took it or not, and others disapproving of the Corporation 'going into business'. All these arguments remind one of similar objections to the Alcester Rural District Council's scheme of water supply and sewerage; no doubt it is in the nature of ratepayers to suppose that they cannot afford and anyway do not need reforms which lead to expense. However, by making this suggestion the Corporation had become hoist with its own petard, for the would-be company offered to abandon its scheme for the sum of £500 paid by the Corporation.[38] This that body duly did and nothing more was heard of the Stratford-on-Avon District Water Company. Curiously enough none of the promoters of the scheme seem to have been identified, at least in *The Stratford Herald*,which was favourably disposed towards sanitary improvements. Since it seems unlikely that complete strangers floated the Company with the intention of blackmailing the Corporation, it is at least possible that the promoters were sanitary reformers in the town who hoped to force the local authorities into taking action. If this was indeed the plan it succeeded admirably.

On 19th January 1882 Edward Pritchard C. E. was asked to report on a scheme of sewerage and water for the town. In his report, described in the Stratford-on-Avon Herald on 7th April 1882, the engineer described his general intentions with regard to the water supply.[39] These were to supply the town with fifteen gallons per head per day with a head of at least sixty feet and to aim for supply by gravitation – he seems to have been a gravitation enthusiast. After discussing various sources of water and rejecting them, he eventually proposed to sink 'wells and perforated collection pipes' into the gravels at Oxstalls farm to the north east of the town, pump the water to a covered reservoir near Welcombe and deliver it by gravity to Stratford. This scheme seemed to embody elements of both Pritchard's Warwick water supply and the Alcester Waterworks Company's system. It was never started. The reason is not known, and *The Stratford Herald* seems silent on the matter until 22nd June 1883 when it records that a new scheme by Pritchard had been adopted by the Corporation.

This, the Snitterfield scheme, is still in operation today. It was to take water from the Snitterfield Brook, lead it by an underground conduit into a reservoir twenty-two feet deep and over

four acres in extent, holding 15,500,000 gallons. The water was to be filtered. Pritchard estimated the cost at £17,300 and recommended that the land was to be purchased but no start made for the present. By 1885 the works were nearing completion and were described by G. H. Fosbroke in his annual report to the Urban Sanitary Authority; they were to supply fifteen gallons per head per day and the reservoir held 19,200,000 gallons or 116 days supply at 150,000 gallons daily. The works had cost £21,000.

By the time of *The Return as to Water Undertakings* the capacity of the reservoir had been increased to 20,340,1100 gallons and the service reservoir for filtered water held 80,500. The daily supply was 104,000 gallons and the supply was examined chemically every quarter.

Although the Snitterfield scheme still remains much as described in the Return, it no longer supplies most of the town's water. The greater part of the daily supply is derived from a number of deep boreholes sunk around the town from the 1920's onwards.[40]

One further Warwickshire scheme is worthy of note because of connection with a famous name in water supply engineering. This was the Rugby water improvement scheme of 1865, intended to supplement an earlier scheme of 1852. The engineer whose name appears upon the deposited plans is Thomas Hawksley, and the new plan was to take water from the River Avon near Brownsover Mill.[41] It would then gravitate to a settling tank, be pumped to filter beds, then pumped again to a main in the existing system. According to Kelly's Directory of 1892 however, the water was pumped to a reservoir directly from the river, then gravitated to two filter beds, then to a settling tank from which it was piped to the mains supplying the town. On the whole it seems likely that Kelly has it wrong. According to the entry in the Return As to Water Undertakings, Rugby Urban district Council used two sources. One of these was the River Avon at Brownsover (presumably Hawkesly's scheme) and the other was described as 'an upland gathering ground' at Hillmorton. This must have been the earlier scheme for Kelly's Directory of 1892 describes the 1852 supply as from 'a land drainage system' and as providing 50,000 gallons daily. The upland drainage scheme is said in the Return to yield 52,500 gallons daily suggesting that they were one and the same.

The waterworks filtered the water, and had total storage amounting to 3,050,000 gallons. It supplied 757,445 gallons per day as well as 9,725 in bulk. Rather surprisingly in view of the nature of the source used, the supply was only analysed each half year; and then by chemical rather than bacteriological methods.

The only other town in Warwickshire whose water supply needs mention is Royal Leamington Spa, which drew its water from two deep wells in the New Red Sandstone. One of these yielded 650,000 gallons per day and the other 600,000. The water was unfiltered and there were two reservoirs, one for 1,000,000 gallons and another for 100,000. The waterworks supplied 703,000 gallons daily and the supply was analysed chemically each quarter. [42]

When the Alcester Waterworks Company is compared with organisations providing water to other Warwickshire towns it appears that similar factors operated to bring them into being and that although they were all greater in scale than the Alcester Company, the difference was one

of degree rather than of kind. In terms of the technology used and the standards of water treatment employed the Alcester Waterworks Company was not out of place among the suppliers of Warwickshire towns.

The point has been reached where it would be valuable to draw together all the threads of the arguments presented above, and attempt a brief analysis of the findings. The purpose of this study has been to investigate the factors which brought piped water to a small and by no means prosperous Warwickshire town at a relatively early date, and see how its development was influenced by social and technical factors. Some of the factors which brought the Company into being were general and would apply to all such concerns. Public Health legislation and the activities of Medical Officers of Health would come into this category, whereas the attitude of the local landowners and the social composition of the town on the other hand, would be matters whose influence might vary from one place to another. In general though it would be true to say, at least as far as Warwickshire is concerned, that the hostility of the smaller ratepayers to reforms which would strike their pockets was very general. Strangely enough the opposition could have paradoxical effects; whereas ratepayer' s opposition was the reason why Alcester 's water was supplied by a limited company rather than the local authority, in Stratford-on-Avon the result was exactly the reverse. The factors which brought water concerns into being in the late nineteenth century would appear to have been a complex mixture of central government activity, local politics, scientific knowledge and ignorance, personal avarice, and activity or inertia on the part of local health officials.

The form of water supply which a town might have on the other hand, was determined by technical factors relating to the local geology, and economic factors derived from the cost of pumping and the capital cost of storage. Before the widespread use of the gas or oil engine, a small concern might have difficulty with pumping since it could not produce steam power cheaply enough. Water power would be the only likely alternative. Initial capital cost tended to make stream capture and gravitation relatively unattractive for commercial water suppliers. A small undertaking would be likely to use technology of a very simple kind, to employ very few people and to undertake either rudimentary water testing, or more likely, none at all. It would be likely to use wells, springs or boreholes as sources. Its financial performance if a commercial supplier would be likely to be unimpressive at first, especially if it had to undertake pumping without an economic source of power. It would be unlikely to chlorinate the water until the late 1930's, and would probably not filter it. If sufficient capital were sunk early enough the concern might become highly profitable in money terms by the 1940's or 1950's.

In the course of the history of a water-supplying concern, the most important factors affecting its technical development would be economic ones, the supervision of the local health authority and the activities of central government.

In all these respects there appears to be every reason to believe that the Alcester Waterworks Company was typical of a small water undertaking founded in the late nineteenth century. Although the Company had its faults, its water supply did represent a great sanitary benefit to the

town which it served for nearly seventy years, and it is a record of which the promoters and directors would have no reason to be ashamed.

## Notes and References to Chapter 6


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42. These details are taken from *The Return as to Water Undertakings*.

# Chapter 7 : Appendices, Bibliography and Index

## Appendix A

A Description of the Geology of the Alcester Area

The Alcester area is underlain by rocks of the Triassic age. They consist of the reddish brown clays, silts and mudstones (with bluish-green mottled patches) which make up the Keuper Marl, and they include a band of the pale greenish-grey, fine grained Arden Sandstone. These rocks crop out on either side of the Arrow Valley, the Arden Sandstone band occurring mainly at around 200, feet above sea level, but between Arrow and the north eastern edge of Alcester it has been down-faulted to outcrop at a lower level on the western side of the valley. The Keuper Marl is 80-90 feet thick beneath Alcester and the Arden Sandstone band thickens northwards from about 3 feet near Arrow to a maximum of 12 feet near Alcester. At the site of the Alcester Waterworks pumping station (SP 082567) a weathered section of Arden Sandstone shows 6 feet of whitish grey sandstone with a six inch band of green and red mottled marl about 2/3 of the way down.

Over much of the area on either side of the river valley these rocks are overlain by recent deposits of alluvium forming the flood plain, and by river terrace deposits consisting of gravelly sands and loams. At Arrow, terrace No. 2 is ten feet thick.

The Keuper Marl is virtually impermeable and acts as a confining medium to the groundwater under hydrostatic head in the underlying Keuper Sandstone. However the Arden Sandstone band acts as a minor aquifer, and bores in Alcester have yielded flows of the order of 0.75 to 1 litre per second.

The Alcester Waterworks Company's pumping station at Arrow is situated at the outer edge of river terrace No.1 which partly overlies the Arden Sandstone in this area. The springs to the east of the river, in Oversley hamlet are on river terrace No. 1, which here overlies impermeable Keuper Marl.

The town of Alcester itself is built mainly on river terraces, 1 and 2 , which for much of their extent under the town, overlie Arden Sandstone.

## Appendix B

An Extract from the Notice of Application to the Board of Trade for a invisible Order to empower the Alcester Waterworks Company to construct works in the parishes of Arrow, Alcester and the Hamlet of Oversley Dated 14th November 1877

Notice is hereby given that application is intended to be made to the Board of Trade under the provisions of the Gas and Waterworks Facilities Act 1870, for a Provisional Order authorising the Alcester Waterworks Company Limited, hereinafter called the Undertakers, to construct and maintain the Aqueducts, service Reservoirs, Mains and other Works described in this notice, or some or one of them, or some part or parts thereof respectively, for the purpose of supplying water for conferring upon them the following, or some of the following powers, namely:

To drain and impound the water of the Stream known as the Rock Mill Stream, from a point situate in a Field in the Parish of Arrow, in the County of Warwick, in the occupation of Mr. Henry Shailer Jackson, to the mill pound on the site of the Rock Mill, and to construct all necessary dams, waste and regulating valves, and appurtenances.

To construct an Aqueduct or Watercourse from the Spittle Brook at a point no more than 100 yards from the Cold Comfort Road in the parish of Arrow aforesaid, through certain fields in the occupation of the said Henry Shailer Jackson, to the Rock Mill Stream in a field in the said parish of Arrow, in the occupation of Mr. Henry Hunt, with dams regulating and waste valves and appurtenances.

To sink a well and a borehole, and construct a pumping station on the site of the Old Rock Mill, in the said parish of Arrow, with waste culvert underneath the Alcester and Evesham Road into the lower part of the Rock Mill Stream, with all necessary works and appurtenances To construct an aqueduct or watercourse from the spring, or springs, in a meadow in the Hamlet of Oversley, in the said County of Warwick, belonging to Sir Nicholas William George Throckmorton, baronet, in the occupation of Mrs. Elizabeth Harwood, under the River Arrow and the Evesham and Redditch Railway, and Alcester and Evesham Road, to the said well at Rock Mill, with all necessary dams regulating valves and appurtenances.

To construct a Service Reservoir on the Grunt Hills, in or about certain fields in the said parish of Arrow, in the occupation of the said Henry Hunt. To lay Mains or Aqueducts to and from the said Pumping Station and Service Reservoir, and throughout the streets and roads of the said parishes of Alcester and Arrow, and Hamlet of Oversley aforesaid.

The Aqueducts and Works proposed to be authorised by the Order will be made to pass from, in, through, or into the

parish of Arrow, the Hamlet of Oversley, and the Parish of Alcester, all in the County of Warwick.

The proposed Provisional Order will incorporate with itself the Lands Clauses Act save as therein mentioned, the Waterworks Clauses 'I Act, 1847 , and the Waterworks Clauses Act, 1863, with such variations, therein as may be deemed necessary or expedient, and the Provisional Order will contain powers for effecting the objects, or some of the objects, and for conferring on the undertakers the powers or some of the powers following.

To authorize the undertakers to enter upon and open the surface of, and to alter, widen, and otherwise interfere with highways, public roads, ways, footpaths, watercourses, sewers, drains, pavements thoroughfares and water pipes within the said parishes of Arrow and Alcester and the Hamlet of Oversley in the County of Warwick, for the purpose of constructing, maintaining, repairing, removing, renewing, altering, or reinstating the proposed mains and other pipes, or for substituting others in their place, or for the other purposes of the Provisional Order.

To provide for the maintenance and repair of the wind or some portion of the highways and roads, under which any of the proposed mains and pipes may be laid.

To enable the undertakers, for all or any of the purposes of their undertaking, to acquire by agreement, land or buildings, or to take easements over lands, and to erect buildings or conveniences on such lands.

To enable the undertakers to supply water for all purposes within the Parishes and Hamlet before mentioned, or some, or one of them.

To enable the undertakers to levy rates for the water supplied by them.

And the Provisional Order will vary or extinguish all rights and privileges inconsistent with, or which would, or might, in any way interfere with its objects, and will confer other rights and privileges upon the undertakers.

# Appendix C

## Details of Estimation of the Power Output of the Waterwheel at the Arrow Pumping Station

Details of a method for finding the power produced by a water wheel have been given by Starmer and what follows is essentially an application of his techniques.[1]

The waterwheel at the Arrow pumping station was of the pitchback type, so far as it is possible to tell from the visible remains of the device. This means that the effect of gravity, acting on the filled, or partly filled buckets of the wheel is the most important for consideration; the effect of the kinetic energy of the water running on to the top of the wheel would be to impede the rotation, since the top of the wheel is moving towards the water supply with a wheel of this kind. This treatment will ignore the effect of the impact of the water on the top of the wheel, since this should be very slight in a well designed pitchback wheel of this kind.

In order to calculate the power output of a waterwheel from its visible remains, the following pieces of information are needed :-

(a) The volume and hence the mass of water in each bucket on the loaded half of the wheel's circumference.

(b) The number of buckets around the circumference.

(c) The radius of the whee].

(d) Its rotational speed.

The radius of the wheel is easily measured and amounts to 2.75 metres for the Arrow waterwheel, and there are 56 buckets around the rim. The rotational speed could not be measured since the wheel is no longer workable, but the rule which was applied by millwrights and quoted by Starmer was that the linear speed of the wheel rim should be about 3 feet per second for smaller wheels or 6 feet per second for larger ones. In the absence of any objective definition of large and small, the Arrow waterwheel was deemed to be small, and its rim velocity assumed to have been 3 feet per second when operating.

The estimation of the volume of water in each bucket is more complicated. Firstly the shape of the bucket is needed. This was obtained by carefully inserting a thin lead strip into a bucket, pressing it to conform to the shape, then withdrawing it. The outline of the strip was then carefully followed in pencil on a sheet of paper. This gave the shape of the cross section of the bucket and so its area and hence the volume of the bucket knowing its width could be calculated. However, the practice of millwrights was to arrange things so that the buckets were never more than partly filled. This was necessary because if they were completely full at the top of the wheel, an excessive quantity would run to waste as the bucket tilted in its passage from the top of the wheel to the bottom. Fairbairn, in his work on the subject, states that '..... it is undesirable that the buckets should ever be much more than two-thirds full'.[2] This arrangement would give the maximum power for a given amount of water, since it minimised wastage.

The problem then, was to determine the water level in the buckets of the Arrow waterwheel when they were only two-thirds full. To find this, the cross section of the bucket was traced, full size, on to thick tracing paper and cut

into slices, each two centimetres wide, parallel to the water level when the bucket was half way between the top and bottom of the wheel. The slices were then weighed.[3] Since the mass of one square metre of the tracing paper was known, the mass of each slice gave its area, and their total mass the area of cross section of the whole bucket. Finding the depth of water in the bucket when it was two-thirds full was a matter of plotting a graph of cross-sectional area against depth of water in centimetres, and reading off depth of water when the area was two-thirds of the total.

The mass of water in a bucket when it was two-thirds full could now be found, and each bucket must have contained this mass of water up to the point where its rotation allowed spillage to begin. This position was estimated by eye, and checked by counting squares to ensure that the water level at the 'just spill point' would correspond to the bucket being two-thirds full. The result is shown in figure 7.1, which shows a cross section of the bucket with the water levels marked to correspond to the two-thirds full point and the point where water would just spill from the bucket.

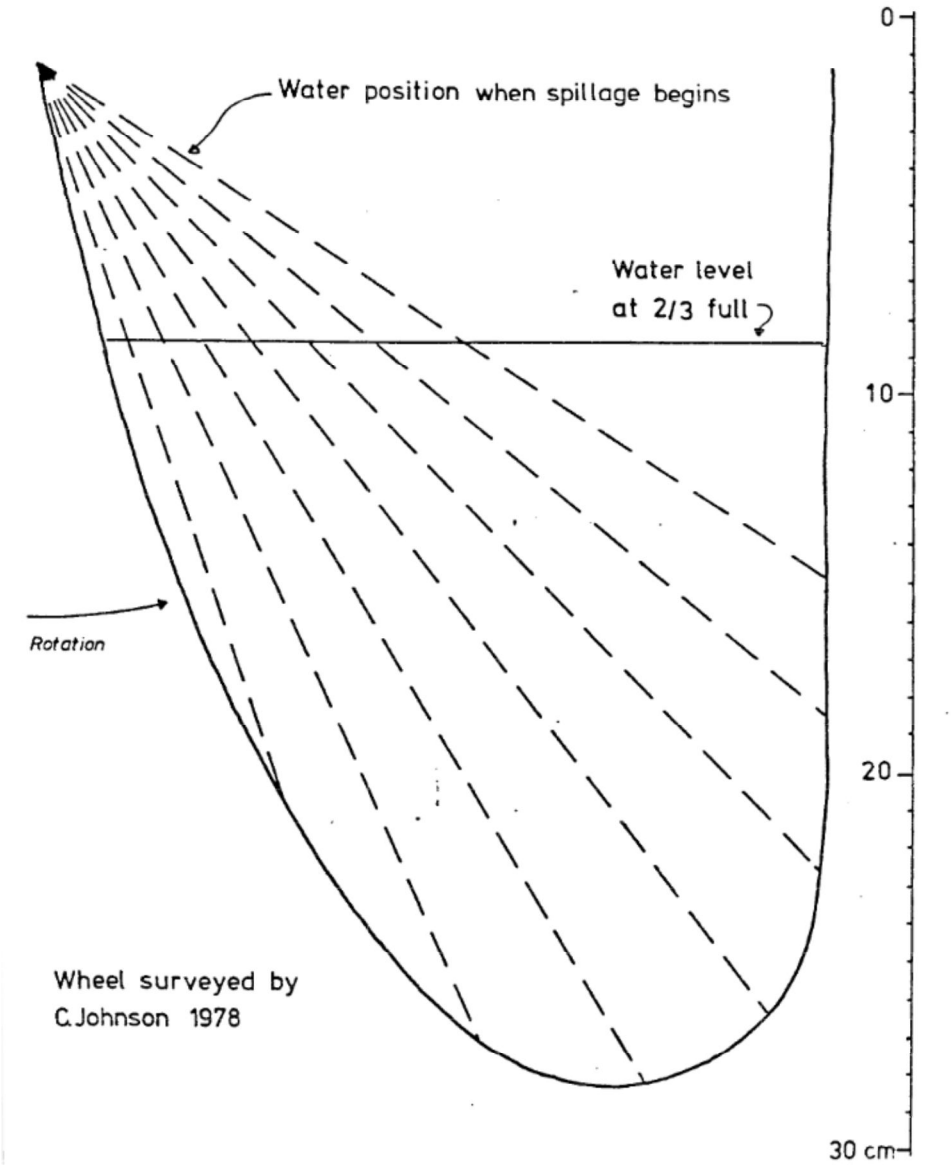


**Figure 7.1 : Water levels at successive bucket positions after spillage begins**

In passing from the top of the wheel to the bottom, a bucket rotates through 180 degrees, which means that for 56 buckets 6.4 degrees of rotation occurs between successive bucket positions. Since the bucket will begin to spill water after 121 degrees of rotation from the top of the wheel, beyond this point all the buckets must be less than two-thirds full. The volume that they would actually contain was found by drawing on tracing paper the successive positions of the water level corresponding to 6.4 degrees rotation of the bucket. The paper sections were then cut and and weighed so that the cross sectional area could be calculated and from this the volume and mass of water in the buck at

each position. The results are shown in figure C. 1.

This procedure showed that the last two bucket positions before the bottom would have been empty, and the one at the top was assumed to be empty also. If we number the buckets fro: top to bottom as 0-28, the mass of water in each bucket would be as shown in table 7.1 below.

**Table 7.1: Masses of Water at Successive Bucket Positions of the Arrow Waterwheel**

| Bucket Position | Mass of Water Present (kg) |
|---|---|
| 0 | 0 |
| 1-19 | (24 each), 456 total |
| 20 | 20.5 |
| 21 | 16.7 |
| 22 | 12.4 |
| 23 | 8.0 |
| 24 | 4.0 |
| 25 | 1.0 |
| 26 | 0 |
| 27 | 0 |
| 28 | 0 |
| Total Mass of water on loaded side of wheel | 518.6kg |

Having found the mass of water on the loaded side of the wheel, the calculation proceeds as follows:

Average mass of water per bucket = 518.6 / 28 kg
= 18.5 kg

Work done when 1 bucket descends across 1 diameter
= 18.5 x 9.8 x 5.5
= 997 joule

Assuming that the rim velocity is 3 feet, or 0.9144m, per second then

Revolutions per second = 0.9144 / (3.142 x 2 x 2.75)
= 0.0529

Hence buckets descending per second
= 0.0529 x 56
= 2.96

Thus work done per second = 2.96 x 997
= 2.955 kilowatts

**After allowance for friction etc. = 2.30 kilowatts**

## Notes and References to Appendix C

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2. Fairbairn, Sir William; *A Treatise on Mills and Millwork*; 4th edition, Longmans, London, page 121
3. An accurate chemical balance was used for the weighings.

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